

THE GENUS *GERANIUM* L. IN THE SOUTH WESTERN PACIFIC AREA.

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Plates vi-vii; ten Text-figures.)

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Synopsis.

All the species known to occur in Australia, New Zealand, New Guinea and Indonesia are described and discussed. The following new taxa are described: *G. antrorsum*, *G. drummondii*, *G. graniticola*, *G. neglectum*, *G. obtusisepalum*, *G. solanderi* var. *grandis*, *G. potentilloides* var. *abditum* and *G. sessiliflorum* ssp. *novaezelandiae*; *G. solanderi* nom. nov. is proposed to replace *G. pilosum* Sol. ex Willd. non Cav. The following new combinations are made: *G. potentilloides* var. *ardjuneense* (Zoll. et Morr.) and *G. sessiliflorum* ssp. *brevicaule* (Hook.). The indigenous species show fairly close affinities with species found in South America.

INTRODUCTION.

The Australian species of *Geranium* were last revised by Knuth (1912). His treatment in general is unsatisfactory. He divides them between three more or less widely separated sections, which seem to have been based upon mainly geographical and not morphological considerations. Section *Andina* comprises those species, usually occurring at high altitudes, with compact and much branched perennial stems, or caulorrhiza, and usually very short flowering stems; the roots are robust and branched, not napiform. Knuth's morphological delimitation of this section would seem to be basically sound, although the hybrids between *G. sessiliflorum* and *G. potentilloides* may cast some doubt on this. Sect. *Chilensia* is based on the napiform root and perennial or biennial habit. Within this section is included "*G. pilosum* Forst. f." (*G. solanderi*), some of the varieties of which occasionally do not show this character. In Sect. *Columbina* he includes *G. dissectum* var. *glabratum* Hook. f. (*G. homeanum* Turcz.) which is not an annual, the main key character for the section. Sect. *Australiensia* is a rather nebulous conception and Knuth himself suggests relationships with several other sections; the solitary flowers and the thickened, but not napiform, tap-root appear to be his most significant characters.

Bentham (1863) had previously included all except the alpine species within *G. dissectum* var. *australe*, recognizing only two rather ill-defined "races", i.e., "*pilosum*" and "*potentilloides*". This is quite clearly most unsatisfactory now, if only from the point of view of the International Code of Botanical Nomenclature. *G. dissectum* is well defined from the Australian native species by a number of important characters that can be examined in the key and descriptions below.

The taxonomic arrangement adopted below is based primarily upon the characteristics of the seed coat alveolae (Pl. vi), the indumentum (Pl. vii) and the solitary or twinned flowers. It is backed, to some extent, by crossability. Whilst Knuth's sectional names are used, it does not imply that the present author believes that they should be recognized as sections, when the genus is considered as a whole. To some extent *G. homeanum* connects sects. *Australiensia* and *Chilensia* in Australia and it may be unsatisfactory to recognize these at sectional level. On the other hand, the hybrids *G. sessiliflorum* ssp. *brevicaule* × *G. potentilloides* var. *abditum* may make the taxonomic difference between them less than that of a section.

As with *Pelargonium*, the whole genus is badly in need of revision and, until an up-to-date, overall picture can be established, the category to which each supra-specific taxon is to be assigned must remain undetermined.

The Table of Names provides an index to the present author's views on the position of various names that have been proposed for native Australian *Gerania*.

The descriptions of the introduced species, and of Group I itself, apply only to Australian material. The references provided under the genus and species are to works that are important so far as the Australian material is concerned.

The basis for measurements is generally quite straightforward, but some comment is necessary. The length of the leaf is taken from the petiole attachment to the tip of the middle lobe. The rostrum length is taken as the length of the enlarged style and the mericarp measurements do not include the awn, which is generally given separately.

TABLE OF NAMES.

Name.	Date.	Synonym of
<i>G. pilosum</i> Sol. in Forst. f., non Cav., nom. nud.	1786	<i>G. SOLANDERI</i>
<i>G. patulum</i> Sol. in Forst. f. non Vill., nom. nud.	1786	<i>G. SOLANDERI</i>
<i>G. patulum</i> Sol. in mss., non Vill. nec Sol. in Forst. f.		<i>G. RETRORSUM</i>
<i>G. pilosum</i> Sol. ex Willd. non Cav.	1801	<i>G. SOLANDERI</i>
<i>G. parviflorum</i> Willd. non Curt. nec Andr.	1809	<i>G. HOMEANUM</i>
<i>G. australe</i> (Willd.) Poir.	1811	<i>PELARGONIUM AUSTRALE</i>
<i>G. inodorum</i> (Willd.) Poir.	1811	<i>PELARGONIUM INODORUM</i>
<i>G. RETRORSUM</i> L'Hér. ex DC.	1823	
<i>G. POTENTILLOIDES</i> L'Hér. ex DC.	1823	
<i>G. philonthum</i> DC.	1823	<i>G. POTENTILLOIDES</i>
<i>G. brevicaule</i> Hook.	1834	<i>G. SESSILIFLORUM</i> ssp. BREVICAULE
<i>G. australe</i> Nees in Lehm. non Poir.	1844	<i>G. RETRORSUM</i>
<i>G. microphyllum</i> Hook. f.	1844	<i>G. POTENTILLOIDES</i>
var. <i>debile</i> Hook. f.	1854	<i>G. POTENTILLOIDES</i>
<i>G. ardjunense</i> Zoll. et Mor.	1845	<i>G. POTENTILLOIDES</i> var. ARDJUNENSE
<i>G. potentilloides</i> var. <i>microphyllum</i> . Hook. f.	1854	<i>G. POTENTILLOIDES</i>
var. <i>parviflorum</i> (Willd.) Hook. f.	1854	<i>G. HOMEANUM</i>
<i>G. SESSILIFLORUM</i> Cav.		
<i>G. dissectum</i> var. <i>glabratum</i> Hook. f.	1853	<i>G. HOMEANUM</i>
<i>G. dissectum</i> var. <i>retrorsum</i> (DC.) Hook. f.	1853	<i>G. RETRORSUM</i>
<i>G. dissectum</i> var. <i>patulum</i> Hook. f.	1853	<i>G. RETRORSUM</i>
<i>G. HOMEANUM</i> Turcz.	1863	
<i>G. dissectum</i> var. <i>pilosum</i> (Forst. f.) Hook. f.	1864	<i>G. SOLANDERI</i>
<i>G. TRAVERSII</i> Hook. f.	1867	
var. <i>elegans</i> Chn.	1867	<i>G. TRAVERSII</i>
<i>G. sessiliflorum</i> var. <i>glabrum</i> Knuth	1906	<i>G. SESSILIFLORUM</i> ssp. BREVICAULE
<i>G. pilosum</i> var. <i>grandiflorum</i> Knuth, nom. illeg.	1912	<i>G. RETRORSUM</i>
<i>G. australe</i> (non Nees nec Poir.) Allen	1961	<i>G. RETRORSUM</i>
<i>G. microphyllum</i> var. <i>obtusatum</i> Simp. et Thom.	1943	<i>G. POTENTILLOIDES</i>
<i>G. microphyllum</i> var. <i>discolor</i> Simp. et Thom.	1943	<i>G. POTENTILLOIDES</i>
<i>G. sessiliflorum</i> var. <i>maculatum</i> Simp. et Thom.	1943	<i>G. SESSILIFLORUM</i> ssp. NOVAEZELANDIAE
<i>G. SESSILIFLORUM</i> var. <i>ARENARIA</i> Simp. et Thom.	1943	
<i>G. ANTRORSUM</i> , sp. nov.		
<i>G. DRUMMONDII</i> , sp. nov.		
<i>G. GRANITICOLA</i> , sp. nov.		
<i>G. NEGLECTUM</i> , sp. nov.		
<i>G. OBTUSISEPALUM</i> , sp. nov.		
<i>G. POTENTILLOIDES</i>		
var. <i>ARDJUNENSE</i> (Zoll. et Morr.), comb. et stat. nov.		
var. <i>ABDITUM</i> , var. nov.		
<i>G. SOLANDERI</i> , nom. nov.		
var. <i>GRANDIS</i> , var. nov.		
<i>G. SESSILIFLORUM</i>		
ssp. <i>BREVICAULE</i> (Hook.), comb. et stat. nov.		
ssp. <i>NOVAEZELANDIAE</i> , ssp. nov.		

MORPHOLOGICAL NOTES:

The rootstocks of the species described below can be divided into four main types: (i) Tap-root much branched, thin (annuals); (ii) Tap-root much branched but thick; (iii) Tap-root little branched, slightly swollen, $\pm$ fusiform; (iv) Tap-root thick, napiform, little branched.

To some extent these intergrade with one another, probably as a result of the influence of the environment, but there does appear to be some distinct genetic basis. The first appears in the annual, introduced species only.

The stems are fairly consistent throughout the group in that there are two distinct types, the occurrence of which has not always been noted. All the native species are potentially perennial and possess more or less woody, thickened basal stems or caulorrhiza which have short internodes and are perennial. Even the annual species have comparable stems from which the floriferous stems arise. From these basal stems arise the spirally arranged basal leaves; these are altogether larger than the cauline leaves arising from the floriferous stems, they also have longer petioles, and when

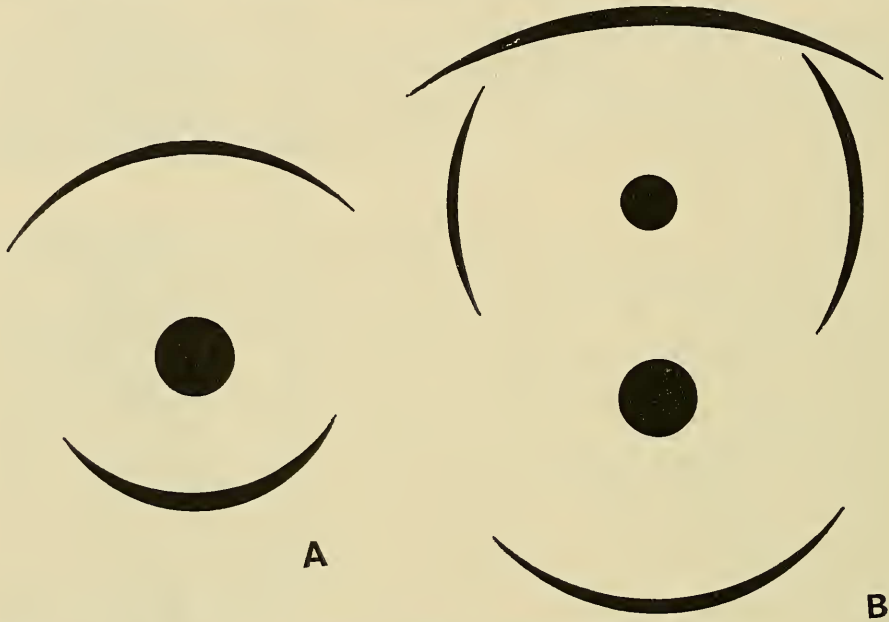


Fig. 1. Diagrams to show flowers, bracts and bracteoles of (a) 1-flower and (b) 2-flower groups.

they die the leaf bases and the stipules are generally persistent upon the stem as dry membranous structures. These leaves are usually more prominent in the winter, at least in the lowland species, and they die during the early stages of the growing season, or are masked by the growth of the cauline leaves. The result is that most previous descriptions are based upon the cauline leaves, omitting the basal leaves from consideration. In the alpine species, *G. antrorsum* and *G. brevicaule*, the basal leaves and stems are the most prominent all the year around.

The annual floriferous stems arise, apparently sympodially, from the basal stems and bearing opposite leaves. In species other than the alpine ones these floriferous stems are elongated and relatively weak, usually much longer than the basal leaves; moreover, in a number of species, they frequently root at the nodes, forming new plants when the intervening part of the runner stem decays, e.g., *G. graniticola*, *G. homeanum* and *G. neglectum*. The alpine species *G. antrorsum* and *G. brevicaule* have very short annual floriferous stems, usually shorter than the basal leaves. It is often reduced to a solitary flower. The two groups, lowland and alpine, then, exhibit a very different superficial appearance during the flowering season. The flowers are borne terminally either solitary or twinned, and the growth of the floriferous stems is sympodial (Eichler, 1887). When the flowers are twinned four bracteoles are present at the base of the pedicels. It appears that the inflorescence is a reduced monochasium retaining the bracteoles of its dichasial ancestry (see Eichler, 1878) (Fig. 1). The solitary condition

of the flower is a further reduction of the inflorescence, leaving only two bracteoles; the flower stalk in this case is herein referred to as a "pedicel-peduncle".

In all the species described below the sepals are arranged quincuncially. The petal aestivation, however, is by no means so consistent, an irregularity which appears to be common in the family. The commonest arrangement in the Australian species appears to be cochlear with quincuncial and convolute arrangements occurring much less frequently.

The five glands alternating with the petals have been interpreted as swellings of the base of the stamens (Eichler, 1878; Knuth, 1912), but this does not appear to be the case. There is a large area between the sepal and the "inner" whorl of stamens and it is upon this part of the receptacle that the nectary develops. In most of the species nectar secretion is extremely active and a large bead collects, trapped between the sepal and the filament. Although the bases of the adjoining petals are provided with hairs, these apparently do not prevent any insects from obtaining the nectar; the nectar usually completely submerges these hairs and in some species the hairs do not overlap at all, e.g., *G. sessiliflorum*.

The Geraniaceae are often cited as having obdiplostemenous flowers. The stamens which lie outermost in the mature flower are certainly those that lie opposite the petals. The sequence of maturation, as measured by dehiscence, does not correspond to their positions in the flower. In fact they follow a quincuncial sequence, the innermost whorl first. Thus, although morphologically obdiplostemenous, physiologically they are not. Possibly the development of the nectiferous gland at the base of the ante-sepal stamens may account for their displacement early in the development of the flower either by sheer force or by nutritional effects. A study of the development and vasculature of the flower might help to clear this up.

Moore (1961) has indicated that he considers there is a fundamental division between those groups having woody stems and alternate leaves and those having opposite leaves on herbaceous aerial stems. Within the first group he includes Sect. *Andina*. The distinction is probably not so very fundamental as a number of species of Sect. *Andina* can, under suitable conditions, produce $\pm$ elongated herbaceous stems, bearing opposite leaves, in place of the (normal) solitary flowers on the caulorrhiza. The caulorrhiza of the "herbaceous" species are homologous with the branches of the "shrubby" species. It should also be noted that in some species, e.g., *G. molle*, the leaves on the flowering branches may be either opposite or alternate (but seldom spirally) arranged.

TAXONOMY.

GERANIUM L., *Gen. Pl.*, 306 (1754); Ait., *Hort. Kew*, 2: 432 (1789); Willd., *Sp. Pl.*, 3: 696 (1801); DC., *Prodr.*, 1: 639 (1824); Benth. et Hook. f., *Gen. Pl.*, 1: 272 (1862); Benth., *Fl. Austr.*, 1: 295 (1863); Moore et Betcher, *Handbk. Fl. N.S.W.*, 54 (1893); Bailey, *Queensland Fl.*, 1: 177 (1899); Rodway, *Fl. Tas.*, 19 (1903); Knuth, *Das Pflanzenreich-Geraniaceae*, 43 (1912); Ewart, *Fl. Vict.*, 681 (1931); Knuth in Engler et Prantl, *Der Natürlichen Pflanzenfamilien*, 2nd ed., 19a: 52 (1931); Black, *Fl. S. Austr.*, ed. 2, 2: 482 (1948); Curtis, *Stud. Fl. Tasm.*, 1: 90 (1956) (applying only to Australian species).

Herbs, usually with one or more basal stems (caulorrhiza) bearing large leaves, from which arise, sympodially, one or more leafy flowering stems. *Cauline leaves* opposite or alternate, dissected, lobed or broadly toothed. *Peduncles* terminally arranged in cincinnal sequence, often with supernumerary accessory buds at each node. *Flowers* twinned or solitary, with four or two (respectively) bracteoles at the base of the pedicels or along the length of the pedicel-peduncle. *Sepals* 5, imbricate. *Corolla* regular; petals 5, free, imbricate. *Stamens* 10, all bearing anthers or, very rarely, 5 staminodal; filaments broad, free or united at the base. *Glands* 5, alternating with the petals. *Ovary* 5-lobed, 5-locular with $2 \pm$ superposed ovules per loculus, with a distinct 5-fid style. *Fruit* with one basal axile seed per loculus, septicidal and generally septifragal so that the seed is actually exposed, this dehiscence carried on upwards into

the enlarged style, each mericarp thus being surmounted by a curved awn which is glabrous on the inside and separated from the central rostrum except at the summit. *Seed* frequently with a distinctly patterned testa and a funicle often equipped with stiff hairs; endosperm very little or absent; embryo with massive induplicate or convoluted cotyledons. 250-300 species mostly temperate but extending onto tropical mountains.

GROUP I. (All introduced.) Annuals, flowers twinned: hairs mostly coarse and minutely glandular with a line of crisped simple hairs on stems and petioles. Pedicels scarcely geniculate or swelling above at fruiting stage. Flowering stems long. Mericarps wrinkled, with a tuft of long white hairs at the top on either side of the ventral suture and breaking away from the awn at maturity. Seed-coat smooth. (= Sect. *ROBERTIANA* Boiss.)

1. *GERANIUM ROBERTIANUM* L., *Spec. Pl.* 681 (1753); Burm. f., *Geran.*, 22 (1759); Willd., *Sp. Pl.*, 3: 714 (1801); DC., *Prodr.*, 1: 644 (1824); Knuth, *Pflrch.-Geran.*, 64 (1912); Hegi, *Ill. Fl. Mitt.-Eur.*, 4: 1712 (1924).

Nomenclatural Synonym. *Robertiella robertianum* (L.) Hank in Underwood-Britton, *North Am. Fl.*, 25: 3 (1907).

Annual herb with thin tap-root and short thin often obsolete caulorrhiza covered with small dry stipules. *Stems* ascending to decumbent, 20-40 (80) cm. long, terete or obscurely grooved, branched, bearing scattered coarse hairs minutely glandular in the young condition, and with a line of denser curled $\pm$ arachnoid simple hairs. Leaves mostly opposite; petioles 2-10 cm. long, thin, bearing scattered coarse glandular hairs and a line of curled ones; laminae ovate to broad-ovate in outline, 2-5 (10) cm. long, 1-5 (8) cm. wide, with scattered coarse minutely glandular hairs on both surfaces $\pm$ appressed (especially on the upper surface) and lines of small crisped simple hairs on the upper surface of the more prominent veins, palmatisect to palmate-compound or ternate; the lobes themselves ovate in outline, pinnatisect or deeply toothed, each secondary lobe or tooth terminated by a short mucronate tip; stipules broad-deltoid to obovate oblong or almost semi-orbicular, up to 3 mm. long and 1.5 mm. wide, glabrescent but for the ciliate margin, membranous, $\pm$ mucronate to obtuse or acute. *Flowers* twinned; peduncles 3-7 cm. long, covered with a minute glandular pubescence and with scattered coarse glandular hairs and a line of crisped simple ones; pedicels 5-10 mm., similar to peduncles, straight and scarcely swollen in fruiting condition; bracteoles lanceolate-deltoid, c. 1 mm. long, acute, membranous, ciliate. *Sepals* 5, ovate to lanceolate or narrow-oblong, 5-7 mm. long, 1.5-2.5 mm. wide with a prominent terminal awn c. 1 mm. long, covered with coarse minutely glandular hairs, membranous towards the margin. *Petals* 5, oblanceolate-obovate to spatulate, 9-12 mm. long including the 4-6 mm. long claw, 3-4.5 mm. wide on the spreading limb, deep pink (to nearly white). *Stamens* 10, all fertile; filaments linear lanceolate, long-acuminate, 6 mm. long; anthers sub-globular; pollen orange. *Fruit*: mericarps ovoid, 2.5-3 mm. long, almost quite glabrous to pilose except for a long tuft of connivent white hairs at the top on either side of the ventral suture, reticulate-ridged but not deeply so and with fewer longitudinal than transverse ridges; awns glabrous except for upper pubescent region; rostrum 1-2 cm. (rarely 3 cm.) long. *Seeds* pale-brown, smooth but dull; raphe $\pm$ basal.

Range. Temperate Eurasia and Mts. of North Africa. Introduced into temperate North and South America. In Australasia only in New Zealand.

Habitat. Disturbed areas.

Typification. There are sheets in LINN of this species labelled by Linnaeus. The synonymy is largely a European problem and is therefore omitted here.

Selected Specimens examined: *New Zealand:* Awakino Gorge, H. H. Allan, 19.11.1928 (CHR 453); Church St, Pukerua Bay, J. D. Hay, 4.2.1949 (CHR 68517); Port Nicholson, H. H. Allan, 13.11.1928 (CHR 812); Railway near Petone, A. J. Healy, 1.11.1945 (CHR 33774); Trentham, Hutt Valley, A. J. Healy, 19.5.1953 (CHR 81413).

2. *GERANIUM PURPUREUM* Vill., *Pl. Delph.*, 72 (1785) et *Hist. Pl. Dauph.*, 1: 272 (1786); Willd., *Spec. Pl.*, 3: 715 (1801).

Nomenclatural synonyms. *G. robertianum* β *purpureum* (Vill.) DC., *Fl. Franc.*, 4: 853 (1805) et *Prodr.*, 1: 644 (1824); Knuth, *Pflrch.-Geran.*, 66 (1912); *G. robertianum* ssp. *purpureum* (Vill.) Murbeck, *Contr. Fl. Tunis.*, 1: 52 (1897); Hegi, *Ill. Fl. Mitt.-Eur.*, 4: 1714 (1924).

Annual herb with a thin tap-root and short thin almost obsolete caulorrhiza covered with small dry stipules. *Stems* decumbent or ascending to 40 cm. tall, terete or obscurely grooved, branched from the base, bearing scattered coarse minutely glandular hairs and a line of small crisped simple ones. *Leaves* mostly opposite; petioles up to 10 cm. long with scattered coarse glandular hairs and a line of small crisped simple ones; laminae ovate to broad-ovate in outline, 2-5 (8) cm. long, 3-7 (9) cm. wide, with scattered minutely glandular hairs on both surfaces and lines of soft $\pm$ crisped simple hairs on the upper surfaces of the larger veins, palmatisect to palmate-compound or ternate; the lobes themselves ovate in outline, pinnatisect or deeply toothed, each secondary lobe or tooth terminated by a short mucronate tip; stipules ovate-oblong to broad-ovate, up to 3 mm. long, glabrescent but for the ciliate margin, membranous, obtuse to acute. *Flowers* twinned; peduncles up to 6 cm. long, covered with a minute glandular pubescence, with coarse scattered glandular hairs and a line of soft $\pm$ crisped simple ones; pedicels up to 10 mm. long, $\pm$ straight and scarcely swollen above in fruiting condition; bracteoles lanceolate-deltoid, c. 1 mm. long, acute, membranous, ciliate. *Sepals* ovate elliptic to lanceolate, 6-7 mm. long, 2-3 mm. wide, with a prominent terminal awn c. 1.5 mm. long with coarse and minutely glandular hairs, membranous towards the margin. *Petals* 5, bright pink, oblanceolate-spathulate, 6-9 mm. long with a distinct claw and spreading limb. *Stamens* 10, all fertile; filaments linear-lanceolate, long-acuminate, c. 5 mm. long; anthers sub-globular; pollen yellow. *Fruit*: mericarps ovoid, 2.5 mm. long, almost quite glabrous but for long tufts of connivent white hairs at the top on either side of the ventral suture, deeply reticulate-ridged with some longitudinal ridges particularly towards the base; awns glabrous except for upper pubescent region; rostrum 1-2 cm. long. *Seed* pale-brown, smooth but dull; raphe $\pm$ basal.

Range. A native of Europe, particularly Mediterranean area, and southwards into Africa (Uganda). Introduced into New Zealand.

Habitat. Roadsides and woodland margins.

Typification. The type has not been examined.

Discussion. Very close to *G. robertianum*, from which it can be distinguished most readily by the yellow pollen and much more prominently reticulate-ridged mericarps.

Specimens examined: New Zealand: nr. Onehunga, H. Carse, 15.10.1928 (CHR 5510); Lara Flats, Penrose, Auckland Isthmus, H. Carse, 15.10.1928 (CHR 5509).

GROUP II. (All introduced.) Annuals, flowers twinned. Glandular hairs conspicuous, often as long as simple ones. Pedicels geniculate, swelling above at fruiting stage. Flowering stems long: mericarps usually pubescent or wrinkled. Seed-coat light brown. (= Sect. COLUMBINA Koch.)

3. GERANIUM MOLLE L., *Sp. Pl.*, 682 (1753); Burm. f., *Spec. Geran.*, 25 (1759); Ait., *Hort. Kew.*, 2: 436 (1789); Willd., *Sp. Pl.*, 3: 710 (1801); DC., *Prodr.*, 1: 643 (1824); Benth., *Fl. Aust.*, 1: 296 (1863); Hook. f., *Fl. N. Zeal.*, 1: 40 (1853) et *Handbk. N. Zeal. Fl.*, 37 (1864); Terracc., in *Malpighia*, 4: 202 (1890); Cheeseman, *Man. N. Zeal. Fl.*, 90 (1906); Knuth, *Das Pflrch.-Geran.*, 57 (1912); Asch. et Graeb., *Syn. Mitt.-Eur. Fl.*, 7: 51 (1913); Hegi, *Illus. Fl. Mitt.-Eur.*, 4: 1701 (1924); Ewart, *Fl. Vict.*, 683 (1930); Black, *Fl. S. Aust.*, 2nd ed., 2: 482 (1948); Curtis, *Stud. Fl. Tasm.*, 1: 92 (1956). Icon: Ross-Craig, *Drawings of British Plants*, 6: 6.34 (1952).

Decumbent or usually ascending annual or short-lived perennial herbs with thin much-branched roots. *Stems* up to 50 cm. long, softly hairy. *Leaves* opposite; petioles up to 7 cm. long on basal leaves shorter on cauline ones covered with villous spreading hairs, laminae orbicular to reniform in outline, 1-0.5 cm. long, up to 3 cm. wide, 5-9-lobed to about the middle with narrow sinuses, each lobe divided into 3-5 obtuse teeth towards

the apex, with scattered villous hairs on both surfaces; stipules lanceolate to oblong, up to 4 mm. long, membranous, villous. *Flowers* twinned; peduncles with villous divergent simple hairs and some glandular ones, 0.8–1.5 cm. long; bracteoles minute, more or less deltoid to ovate, villous; pedicels densely covered with spreading small villous and glandular hairs, up to 12 mm. long, more or less geniculate in fruiting condition. *Sepals* narrow-oblong to elliptic, c. 4 mm. long and 2 mm. wide, villous and glandular hairy, with a very short blunt mucro. *Petals* obovate, about as long as or slightly longer than the sepals, ciliate towards the base, emarginate or bifid. *Stamens* 10; filaments lanceolate, up to 3 mm. long, with a few long hairs on the margin; anthers $\pm$ globular, mauve, c. 0.5 mm. long. *Ovary* glabrous or nearly so; stigmata yellow white or green, c. 1 mm. long. *Fruit*: mericarps glabrous, transversely wrinkled, or smooth, c. 2 mm. long, funicular hairs absent or extremely small; awns glandular and simple hairy; rostrum 6–9 mm. long. *Seeds* ellipsoid, greenish-brown or brown, raphe $\pm$ basal, almost quite smooth.

var. *MOLLE* mericarps wrinkled.

Range. Temperate Australia. A native of Europe, and North Africa, now very widely dispersed.

Habitat. Disturbed land, cultivated or waste places.

Typification. There are two sheets (73 and 74) in the Linnean herbarium, London, pinned together, which have been both labelled *G. molle* by Linnaeus, No. 74 on the back of the sheet, No. 73 on the front. They are, however, specimens of *G. pyrenaicum* Burm. f., a species not recognized by Linnaeus until much later, and have been named so by J. E. Smith.

Sheet 73 does not correspond to Linnaeus' description as it has opposite leaves; for this reason it can be discarded from consideration as a type since Linnaeus' diagnosis describes the leaves as being alternate. The other specimen has some leaves opposite and others alternate; otherwise Linnaeus' description could apply to it, even to the "calycibus muticis", for the sepals have only a tiny, blunt mucro. The trivial epithet "molle", however, scarcely applies to it, and when one considers the emphasis laid on the softness of the indumentum by the authors cited by Linnaeus (see below) it becomes clear that even this specimen must be discarded as a type.

The *nomen specificum legitimum* in the "Species Plantarum" is a new one; the one provided by Linnaeus in "Flora Suecica" is given as a synonym and differs from *G. molle* in "capsulis hirtis". It is possible that he mistook the wrinkles on the mericarps for hairs or that he was referring to the awns only (which is improbable). The Flora Suecica specimen is not extant, but was collected near Lund where both *G. molle* and *G. pyrenaicum* occur. Dalibard, in *Fl. Paris.*, gives a diagnosis which is a copy of Linnaeus' in the "Flora Suecica" except for the alteration of "capsula hirtis" to "capsula hirsutis". He also cites Vaillant's illustration (*vide infra*). Haller's diagnosis includes "foliis mollibus" which is scarcely characteristic of *G. pyrenaicum* but is of *G. molle*. Sauvage in *Fl. Monsp.* gives Haller's diagnosis slightly emended but also states "Geranium foliis alternis, Quia omnia alia foliis oppositis gaudent", which does not apply to the Linnaean specimens entirely.

The most important reference by Linnaeus is to the Vaillant illustration, for it is only in this case that all the characteristics given in Linnaeus' diagnosis are satisfied, with the exception of "Caule ramoso diffuso" which is not contradicted either. "Calycibus muticis" is contrasted in the following species by "calycibus aristatis", i.e., the very short mucro of *G. molle* versus the long one of *G. carolinianum*; such a description of this contrasting character is consistent with his handling of similar cases elsewhere. The agreement of leaf-arrangement should also be recognized.

The general emphasis laid by both Linnaeus and Vaillant on the softness of the indumentum ("molle" and "omnium villosissimum") also indicates that it is Vaillant's illustration that typifies Linnaeus' concept of *Geranium molle* and not the specimens in Linnaeus' herbarium. However, he seems to have had no clear idea of how to apply the

concept since the one specimen of *G. molle* in his herbarium (0.85) is identified as *G. pusillum*, presumably at a much later date.

Vaillant's illustration, *Bot. Paris.*, t. 15, f. 3 (1726), is herewith taken as representing Linnaeus' concept of *G. molle*.

It should be remarked that the alternate arrangement of leaves, stressed so much by both Linnaeus and Vaillant, is not characteristic of the species, plants of which frequently have opposite leaves.

Discussion. A variable species, but there seems little point in recognizing infra-specific taxa other than the very clearly defined one given below.

Selected Specimens examined: *Western Australia:* Subiaco, A. Morrison No. 19095, 18.9.1909 (K); Perth, F. Howard, No. 324 (K). *South Australia:* Mt. Compass, Mt. Lofty Range, J. B. Cleland, 30.10.1921 (AD 96117065); Encounter Bay, J. B. Cleland, 13.9.1931 (AD 96117066); Parklands between Botanic Garden and Rundle Street, Adelaide, H. Eichler No. 12050, 15.10.1956 (SYD). *Tasmania:* 4 miles W. of Strahan, R. Carolin No. 1268a, 14.1.1960 (SYD); Circular Head, Gunn No. 1035, 1842 (BM); Van Diemen's Land, Gunn No. 1035, 1842 (K); Embankment of R. Mersey, Devonport, W. M. Curtis, 28.10.1943 (K). *New South Wales:* Kurnell, R. Carolin No. 535, 29.9.1958 (SYD); Cowra, N. C. Beadle, Oct. 1943 (SYD); Woodstock, R. H. Anderson, 2.11.1932 (NSW 42555); Illawarra district, A. G. Hamilton, 10.1900 (NSW 42553); Murrurundi, R. H. Cabbage, No. 1797, 10.1907 (NSW 42557). *Queensland:* Wallangarra, D. Taylor, 19.10.1952 (BRI 037056); Ballandean, F. W. Clark, 19.10.1956 (K.BRI 037059). *New Zealand:* Port Hills, Christchurch, N. Lothian, Dec., 1936 (K); R. Lynd No. 78 (BM); Seatown, W. R. B. Oliver, 13.11.1921 (WELT 6060); Karaka Bay, W. R. B. Oliver, 16.10.1921 (WELT 6059); Mt. Wellington, T. F. Cheeseman, Oct. 1881 (WELT 30970B); Wairarapa, J. Hector (WELT 30976); Kapiti Island, W. R. B. Oliver, Jan. 1935 (WELT 6053); Invercargill Railway yards, A. J. Healy, 29.4.1945 (CHR 58527); Pt. Elizabeth, north of Greymouth, W. Mackay, 11.1928 (CHR 60404); Upper Hutt, A. J. Healy, 24.10.1950 (CHR 79268); Palmerston North, H. H. Allan, 11.1935 (CHR 17792); Hastings, V. D. Zotov, 2.12.1943 (CHR 58524).

var. *AEQUALE* Babbington, *Man. Brit. Fl.*, 2nd ed., 65 (1847); Clapham, Tutin and Warburg, *Fl. Brit. Isles*, 2nd ed., 309 (1962).

Taxonomic synonyms. *G. molle* f. *c preuschoffii* Abromeit, *Flora von öst-und West-preussen*, 156 (1898); Hegi, *Ill. Fl. Mittel-Eur.*, 4: 1702 (1924).

Mericarps quite smooth.

Range. Probably that of the type variety.

Habitat. Same as the type variety.

Typification. *G. molle* var. *aequale*. Babb. Holotype—near Leamington, J. J. Murcott, 1845 (CANTAB); *G. molle* f. *preuschoffii*—not traced.

Specimens examined: *New South Wales:* 9-mile Hill Reserve, Albany, E. J. McBarron, No. 3672, 2.10.1949 (NSW 42545. SYD). *Tasmania:* W. H. Archer (NSW 42544). *New Zealand:* Colenso No. 4458 (K).

4. GERANIUM PUSILLUM. Burm. f., *Geran.*, 27 (1759); L., *Sp. Pl.*, ed. 2, 957 (1763); Willd., *Sp. Pl.*, 3: 713 (1801); DC., *Prodr.*, 1: 643 (1824); Hanks et Small in Underwood-Britton, *North Amer. Fl.*, 25 (1): 7 (1907); Terrac. in *Malpighia*, 4: 212 (1890); Hegi, *Ill. Fl. Mitt.-Eur.*, 4: 1703 (1924).

Annual herbs with thin tap-root. *Caulorrhiza* usually short, up to 7 mm. wide and covered with brown scariose ciliate stipules. *Flowering stems* decumbent to ascending, often branched, up to 30 cm. long, pubescent with very short simple and glandular hairs. *Basal leaves* somewhat larger than cauline leaves but of short life-duration. *Cauline leaves* mostly opposite; petioles 1–4 cm. long, pubescent with mostly simple hairs; laminae reniform or orbicular to ovate in outline, 5–20 mm. long, 7–25 mm. wide, 3–5-dissected with broad sinuses, covered with $\pm$ appressed simple hairs and small glandular hairs more numerous on the lower surface; the lobes obovate to oblanceolate

in outline, with 2-3 acute to obtuse secondary lobes or teeth in the upper third; stipules membranous, brown, lanceolate, 1-2 mm. long, 0.5-1 mm. wide, glabrescent on the surface but ciliate with long white simple hairs, acute. *Flowers* twinned; peduncles 1-2 cm. long, pubescent with short simple and glandular hairs; bracteoles linear-lanceolate, 1-1.5 mm. long, membranous, brown-red, ciliate; pedicels 6-10 mm. long, glandular and simple pubescent, geniculate at bracteoles when mature but apparently not swelling conspicuously. *Sepals* 5, elliptic to oblong, 3-4 mm. long, 2-2.5 mm. wide, pubescent with very short $\pm$ appressed simple hairs and (in younger stages) numerous minute glandular hairs with longer stiffer simple hairs towards and on the margins, acute or minutely mucronate. *Petals* pale purple-pink, oblanceolate to narrow-obovate, 2-4 mm. long, emarginate. *Stamens* 10, but only five fertile; filaments lanceolate-acuminate, c. 2 mm. long; anthers broad-oblong. *Fruit*: mericarp smooth except for a longitudinal dorsal ridge often with 1-6 pairs of very short lateral ridges (c. one-eighth the breadth of the mericarp), pubescent with short soft closely appressed simple hairs; awns densely clothed with very short simple and some minute glandular ones; funicular hairs absent; rostrum 5-7 mm. long, stigmatic lobes less than 1 mm. long. *Seeds* oblong, c. 1.5 mm. long, with a $\pm$ lateral raphe, very pale brown, smooth but dull.

Range. A native of temperate Eurasia and now introduced into temperate America. In Australasia at present only in New Zealand.

Habitat. Disturbed ground and pastures.

Typification. I have not examined the type, and as synonymy is largely concerned with European forms, this also is not dealt with here.

Discussion. Collections of this species in New Zealand appear to have commenced in 1928, and it may be, therefore, a relatively recent introduction.

Selected Specimens examined: New Zealand: Railway Station, Upper Hutt, A. J. Healy, 8.1.1945 (CHR 97570); Sandford Downs, Balmoral, North Canterbury, A. J. Healy, 6.12.1946 (CHR 70904); Wellington Harbour, A. J. Healy, 2.4.1941 (CHR 33443).

Geranium pratense L. has been recorded once from New Zealand probably as a garden escape; Banks of Avon, rare ex Europe. Sine leg. (CHR 5514).

It does not appear to have thoroughly established itself as a permanent part of the adventive flora of New Zealand.

5. GERANIUM ROTUNDIFOLIUM L., *Sp. Pl.*, 683 (1753); Ait., *Hort. Kew.*, 2: 436 (1789); Willd., *Sp. Pl.*, 3: 712 (1801); DC., *Prodr.*, 1: 643 (1824); Knuth, *Das Pfarch. Geran.*, 55 (1912); Asch. et Graeb., *Syn. Mitt.-Eur. Fl.*, 7: 48 (1913); Hegi, *Illust. Fl. Mitt.-Eur.*, 4: 1705 (1924); Curtis, *Stud. Fl. Tasm.*, 1: 92 (1956). Icon: Ross-Craig, *Drawings of British Plants*, 6: 6.36 (1952).

Annual herb with $\pm$ thickened tap-root. *Caulorrhiza* short brown, but obscured by stipules and petioles, up to 4 mm. wide. *Flowering stems* ascending or erect, sometimes branched, up to 60 cm. long, covered with soft $\pm$ patent glandular and simple hairs. *Basal leaves* usually larger than cauline leaves but of short life-duration. *Cauline leaves* opposite; petioles up to 15 cm. long, glandular and simple hairy; laminae orbicular to reniform in outline, 1-3 cm. long, 1-5 cm. wide, 5-7-dissected with narrow sinuses, covered on both surfaces with soft appressed hairs; the lobes with several, usually obtuse, teeth towards the top; stipules membranous, brown or red, lanceolate to narrow ovate, c. 3 mm. long and 1 mm. wide, acute with a few scattered appressed hairs on the surface and with long simple hairs on the margin. *Flowers* borne in pairs; peduncles glandular hairy, with a very few stiff simple hairs, 2-3 cm. long; bracteoles linear-lanceolate to lanceolate, c. 2 mm. long, red or brown, membranous, ciliate; pedicels similar to peduncles, 1.2-2.0 cm. long, geniculate and swollen above in the fruiting stage. *Sepals* 5, ovate to oblong, 3-5 mm. long, 1.5-2 mm. wide, covered with long soft white simple hairs and some glandular ones, narrowly membranous at the margin and shortly (0.5 mm.) mucronate. *Petals* purple or rose, broad-spathulate c. 7 mm. long and 2 mm. wide, the claw c. 3.5 mm. long and paler than the lamina, entire, glabrous at the base. *Stamens* 10; filaments lanceolate to elliptic-acuminate, c. 4 mm. long and 0.5 mm.

wide, yellowish-white below, pink above, ciliate; anthers yellow, sub-globular to oblong, c. 0.5 mm. long. *Ovary* hirsute; stigmata red. *Fruit*: mericarp smooth, covered with stiff simple hairs with some glandular ones towards the top, awns densely covered with both simple and glandular hairs; funicular hairs $\pm$ erect, 12–20; rostrum c. 1.5 cm. long, upper contracted part plus stigmatic lobes c. 4 mm. long. *Seeds* $\pm$ globular, c. 2 mm. long with a $\pm$ basal raphe, light brown with very prominent alveolae.

Range. Probably a native of temperate Eurasia and now introduced into temperate America. In Australasia at present only in Tasmania.

Habitat. Disturbed ground, waste and cultivated.

Typification. Linnaeus provides a new original nomen legitimum in *Species Plantarum*. There are two specimens in the Linnaean herbarium in London, labelled *G. rotundifolium* by Linnaeus. One of these does not agree with Linnaeus' diagnosis which states "petalis integris". This specimen, with notched petals, is *G. pusillum* and can be discarded as a type. Likewise the Vaillant illustration (*Bot. Paris*, t. 15, f. 1) can be discarded as it, too, shows very distinctly notched petals; it also appears to be *G. pusillum*.

Haller, in the diagnosis cited by Linnaeus, states "Caulis . . . odoratia subviscidi", which is a good description of living specimens conspecific with the second Linnaean specimen, and "Capsulae glabrae", which is not strictly accurate as the carpels are sparsely hairy. It is, however, certainly not applicable to *G. pusillum* in which the mericarps are very distinctly hirsute.

It seems quite in order, then, to select the sheet No. 83 in the Linnaean herbarium as the LECTOTYPE.

Discussion. Not very widespread yet, but may become more important. It can be distinguished: from *G. molle* by the hairy, smooth mericarps, the longer rostrum, the entire petals and the deeply alveolate seed-coat; from *G. dissectum* by the wider leaf-lobes, shorter awn (or mucro) on the sepals and long-clawed glabrous petals.

Specimens examined: Botanical Gardens, waste ground, Hobart, W. M. Curtis, No. 4. 1942 (K); Waste ground, Launceston Tasmania, W. M. Curtis, 28.10.1943 (K).

6. GERANIUM DISSECTUM L., *Cent. I. plant.*, 21 (1755) et *Amoen. Acad.*, 4: 282 (1760) et *Sp. Pl.*, ed. 2, 956 (1763); *Burm. f., Geran.*, 21 (1759); Willd., *Sp. Pl.*, 3: 712 (1801); DC., *Prodr.*, 1: 643 (1824); Knuth, *Das Pflrch.-Geran.*, 51 (1921); Asch. et Graebn., *Syn. Mitt.-Eur. Fl.*, 7: 43 (1913); Hegi, *Illus. Fl. Mitt.-Eur.*, 4: 1681 (1924); Fernald, *Rhodora*, 37: 298 (1935); Bobrov in Schischkin et Bobrov, *Fl. U.S.S.R.*, 14: 74 (1949); Curtis, *Stud. Fl. Tasm.*, 1: 91 (1956). Icon: Ross-Craig, *Drawings of British Plants*, 6: 6.37 (1952).

Taxonomic Synonyms: *G. angustifolium* Gilib., *Fl. Lith.*, 2: 176 (1786); *G. palmatum* Picard in *Mem. Soc. Agric. Boulogne*, Ser. 2, 1: 122 (1937); *G. minimum* Picard, *loc. cit.*, 122 (1837).

Decumbent or ascending annual herbs with thin branched roots and short caulorhiza. *Stems* up to 40 cm. long, obscurely angled and with scattered reflexed simple hairs. *Leaves* opposite; petioles up to 8 cm. long on basal leaves, shorter on cauline ones, covered with divergent simple hairs; laminae orbicular to reniform in outline, up to 2.5 cm. long and 4 cm. wide, usually c. 1.5 cm. long and 2.5 cm. wide, deeply palmately divided into 5–7 (9) narrow-oblong to linear lobes, themselves divided into linear acute secondary lobes or long teeth, with scattered hairs appressed on both surfaces; stipules narrow-deltoid to lanceolate, 4 mm. long, up to 1 mm. wide, more or less membranous, usually reddish in colour, with scattered superficial hairs, ciliate. *Flowers* twinned; peduncles 1–1.8 cm. long, with scattered retrorse simple hairs and few glandular ones; bracts linear-deltoid, up to 2 mm. long, otherwise similar to the stipules; pedicels 5–10 mm. long, with scattered simple hairs below succeeded by glandular ones above, geniculate at the bracteoles and swollen above in the fruiting condition. *Sepals* lanceolate to narrow-elliptic, 6–8 mm. long, 2–3 mm. wide, covered with glandular and some simple hairs of same length, usually prominently veined, ciliate, acuminate with an awn c.

1.5 mm. long. *Petals* oblanceolate, somewhat longer than sepals, emarginate, deep pink, paler and ciliate towards the base. *Stamens* 10; lanceolate-acuminate, up to 3 mm. long, ciliate; anthers with a blue dehiscence line; pollen blue. *Ovary* hirsute; stigmata white on the inner surface, c. 1 mm. long. *Fruit*: mericarps hirsute, 2.5 mm. long; funicular hairs absent or much reduced; awns with long glandular hairs; rostrum 10–12 mm. long. *Seeds* pale brown, more or less globular, very distinctly isolaterally alveolate, raphe basal.

Range. Temperate Australia, New Zealand, but only in the cooler parts. A native of Europe, but now very widely spread.

Habitat. Waste places generally.

Typification. *Geranium dissectum* L. Holotype. There is one sheet in the Herbarium of Linnean Society, London, which agrees with the Linnaean description and is labelled by Linnaeus.

Discussion. This species has been confused with all of the native species except the high alpine ones. It has been usual practice to refer them all, including the one at present under discussion, to *G. dissectum* var. *australe* Benth. It is, however, quite distinct; the leaves have $\pm$ linear lobes; the pedicel and rostrum have long glandular hairs; the sepals have an awn c. 1.5 mm. long; funicular hairs are absent; the seed coat is pale brown with very characteristic alveolae and the raphe is mostly basal. There seems to be little doubt that it is not native.

The lengthy synonymy provided by Knuth is quite unreliable.

It appears to be a fairly variable species, but the Australian specimens correspond quite well with the type.

The species is also found in New Zealand and the Antarctic Islands.

Selected Specimens examined: *New Zealand:* Prov. Canterbury, Sinclair and Haast, 1860–61 (K) *pro parte*; Kermadec Group, Sunday Island, T. F. Cheeseman No. 4 Com. 5/1889 (K); Auckland, ex herb. Kirk No. 147 (BM); Tokomaru Swamp, Manawata Co., H. Carse, Jan. 1925 (WELT 31008); near Auckland, L. Cockayne, 833/5 (WELT 31010); Whangarei, H. Carse Oct. 1897 (WELT 30993); Mt. Wellington lava fields, D. Petrie, Nov. 1910 (WELT 30996); Palmerston North, C. E. Woodhead, 1.12.1934 (CHR 17838); Morton, I. W. Davey, 30.12.1938 (CHR 21558); Upper Hutt, J. A. Hay, 17.12.1950 (CHR 82587). *South Australia:* Mt. Lofty Range, National Park, J. B. Cleland, 13.12.1952 (AD 96117086). *Victoria:* Melbourne, Adamson No. 155, 9.10.53 (K); Shepparton, Broken River, F. W. Britten, 11.10.1925 (K). *Tasmania:* Wilmot-Waldheim, 14 miles, R. Carolin No. 1231, 10.1.1960 (SYD); Maning Ave., Sandy Bay, Hobart, W. M. Curtis, 17.12.1943 (K).

GROUP III. Perennials with $\pm$ fleshy roots, rarely napiform. Flowers generally solitary (but cf. *G. homeanum*), pedicels usually geniculate and swelling above at maturity. Flowering stems long. Seed-coat brown, alveolae small, usually shallow and elongated or rarely black with deeper elongated alveolae. (= Sect. AUSTRALIENSIA Knuth.)

7. GERANIUM POTENTILLOIDES L'Hér. ex DC., *Prodr.*, 1: 639 (1824); Hook. f., *Fl. N. Zeal.*, 1: 40 (1852), et *Fl. Tasm.*, 1: 57 (1860), *non* Klotzsch (1862), *nec* Spreng (1826), *non nec* Bonpl. ex Wedd. (1855).

Nomenclatural Synonyms: *G. dissectum* L. var. *australe* Benth., "race" *potentilloides* (L'Hér. ex DC.) Benth., *Fl. Austr.*, 1: 296 (1863); *G. pilosum* Sol. ex Willd. var. *potentilloides* (L'Hér. ex DC.) Ewart, *Fl. Vict.*, 682 (1930); Black, *Fl. S. Aust.*, 2nd ed., 2: 482 (1948).

Taxonomic Synonyms: *G. philonothum* DC., *Prodr.*, 1: 639 (1824); *G. microphyllum* Hook. f., *Fl. Antarct.*, 1: 8, t. 5 (1844); *Handb. N. Zeal. Fl.*, 36 (1864); Cheeseman, *Man. N. Zeal. Fl.*, 89 (1906); Knuth, *Pflrch.-Geran.*, 151 (1912); Simpson and Thompson, *Trans. Roy. Soc. N.Z.*, 73: 156 (1943); Curtis, *Stud. Fl. Tas.*, 1: 91 (1956); Allan, *Fl. N. Zeal.*, 1: 235 (1961); *G. potentilloides* var. β *microphyllum* (Hook. f.) Hook. f., *Fl.*

N. Zeal., 1: 40 (1852); *G. potentilloides* var. *γ*, *debile* Hook. f., *Fl. N. Zeal.*, 1: 40 (1852); *G. sarawakatense* Knuth in *Fedde Rep.*, 45: 61 (1938); *G. microphyllum* var. *obtusatum* Simpson et Thomson in *Trans. Roy. Soc. N. Zeal.*, 73: 156 (1943); Allan, *Fl. N. Zeal.*, 1: 236 (1961); *G. microphyllum* var. *discolor* Simpson et Thomson, *loc. cit.*; Allan, *loc. cit.*

Perennial herbs with thickened but not napiform tap-roots and few (usually only 1 or 2) caulorrhiza up to 4 cm. long covered with the brown persistent leaf base and stipules. *Flowering stems* decumbent to ascending, up to 50 cm. long, pubescent with soft retrorse often closely appressed or very short hairs, sometimes glabrescent basally, often rooting at the nodes. *Basal leaves* not persistent through the summer, larger than the cauline ones but otherwise similar. *Cauline leaves* opposite; petioles slender, 1.5–3.5 cm. long, pubescent with retrorse hairs; laminae deeply palmately 5–7-lobed, semi-orbicular to broad-ovate in outline, 1–3 cm. long, 1–5 cm. wide, pubescent on both surfaces, usually paler and sometimes purplish on the lower surface; lobes oblong to narrow obovate, central one divided into 3 (rarely 5–7) obtuse secondary lobes or teeth, lateral ones less divided and usually making the lamina distinctly cordate; stipules lanceolate, 3–10 mm. long, long-acuminate, often 2-fid, subherbaceous on midrib becoming membranous towards the margin, pubescent. *Flowers* solitary (very rarely twinned); pedicel-peduncles slender, pubescent with soft short retrorse-appressed hairs or puberulent, 2–4 cm. long, with two linear to lanceolate subherbaceous pubescent bracteoles c. 2.5–4 mm. long at the midpoint or lower, geniculate at the bracteoles when mature and swollen in upper part in fruiting condition. *Sepals* 5, lanceolate to narrow-elliptic, 4–6 mm. long, 1.5–2.5 mm. wide, acuminate, pubescent with short more or less appressed hairs and some longer ones, ciliate, scarcely convex in fruiting stages. *Petals* 5, obovate, 5–6 mm. long, c. 3 mm. wide, pink, paler below and with translucent veins, ciliate at margin. *Stamens* 10; filaments lanceolate-acuminate, c. 3 mm. long and 0.5 mm. wide, ciliate at the base at margin. *Ovary* hirsute; stigmata white or pale pink, c. 1 mm. long. *Fruit*: mericarps oblong, c. 3.5 mm. long and 1.5 mm. wide, brown, covered with stiff spreading hairs with some minute glandular ones, funicular hairs c. 25; awns densely covered with short stiff simple hairs and some minute glandular ones on the outer surface. *Rostrum* 9–10 mm. long. *Seeds* dark brown, oblong, 2.0 mm. long, covered with shallow, somewhat elongated alveolae, minutely punctate; raphe lateral.

var. POTENTILLOIDES.

Indumentum mostly retrorse-appressed, that of the sepals soft and antrorse-appressed. Seed reticulation small but not minute. Rostrum c. 9 mm. long. Leaves divided into broad-linear to oblong or obovate segments.

Range. All over Temperate Australia, including Tasmania, New Zealand and Antarctic Islands, but tending to occur in the damper regions more commonly.

Habitat. Various, but generally in forests or woodlands.

Typification. *G. potentilloides* L'Hér. ex DC.—Holotype—Nova Zealandia Banks ("Nova Hollandia" must be misprint in DC's Prodrum) (GEN. photo SYD. isotype BM). *G. microphyllum* Hook. f.—Holotype—Lord Auckland's Group, J. D. Hooker (K. photo SYD.). The type consists of three specimens mounted towards the top of a sheet which also bears other apparently conspecific specimens. *G. philonothum* DC.—Holotype—In Novae Hollandiae ora merid sine coll. (GEN. Photo SYD.). *G. potentilloides* var. *debile* Hook. f.—Syntypes—Colenso, No. 1638 (K), and Raoul (K) (photos SYD.).

G. potentilloides Klotzsch in *Bot. Ergeb. Waldem Reise*, 123, t. 17 (1862), is a later homonym of *G. potentilloides* L'Hér. ex DC.

G. microphyllum var. *obtusatum* Simp. et Thom.—Holotype—Flagstaff Hill near Dunedin, G. Simpson & J. S. Thomas (CHR 75698). *G. microphyllum* var. *discolor* Simp. et Thom.—Holotype—Port Hills, Christchurch, G. Simpson (CHR 62979).

Discussion. The New Zealand and Antarctic Islands specimens were separated by J. D. Hooker as var. *microphyllum* or *G. microphyllum*. The type from Auckland Group differs from most in having somewhat coarser pedicel hairs, smaller leaves and smaller,

more obscure alveolae on the seeds. All these conditions are found in some other specimens. It seems inadvisable to recognize *G. microphyllum* as a separate taxon at present.

The type variety shows close affinity with *G. magellanicum* Hook. f., a native of South America. The latter, however, has consistently twinned flowers; apparently the petals are consistently white and the indumentum is somewhat coarser. Allan in *Fl. New Zeal.*, following Simpson and Thompson, recognizes two varieties of *G. microphyllum*. These do not correspond to any Australian material and gradations between their characters and those of the type occur. Moreover, many of the New Zealand specimens show long, stiff, patent hairs on the sepals, frequently associated with

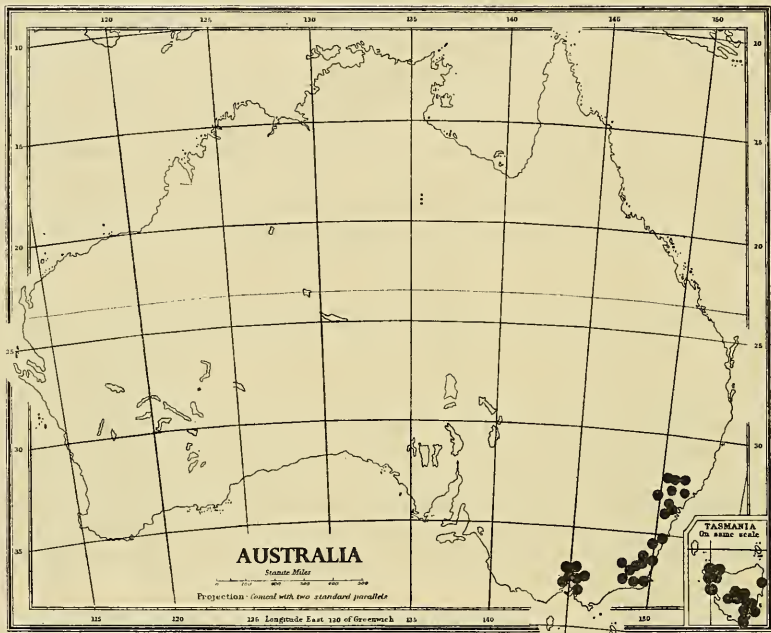


Fig. 2. Distribution of *G. potentilloides* var. *potentilloides* in Australia.

short (0.5 mm.) sepal awns and smaller leaves. This correlation of characters is not constant, neither have I been able to determine any geographical or ecological characteristics associated with this form from the herbarium labels; both var. *obtusatum* Simpson et Thomson and var. *discolor* Simpson et Thomson appear to show these characteristics. Some specimens show divergent glandular hairs. The situation can only be understood by some further fieldwork.

The specimens from the Antarctic Islands, i.e., Auckland Island and Campbell Island, are similar, differing in the long coarse hairs on the sepals, which, however, are appressed and not divergent as in the forms mentioned above. This corresponds to *G. microphyllum*, but the difference is not specifically distinct.

New Zealand authors have frequently remarked upon the possibility of hybrids occurring between "*G. microphyllum*" and *G. sessiliflorum*. This could explain some of the variability, but, so far, there is no direct evidence of such hybridization.

Specimens examined: South Australia: Caroline Forest Reserve, E. N. S. Jackson, No. 242 17.11.1959 (AD 96104260). Victoria: Healesville, N. N. Donner No. 420, 28.10.1961 (AD 96212003); Mt. Drummer, R. Carolin No. 1906, 15.2.1960 (SYD); Mt. Buller, R. Carolin No. 1096, 5.1.1960 (SYD); Delatite River, F. Mueller, 21.3.1853 (MEL); Emerald, Mr. Pitcher 8.12.17 (MEL); South Morang, P. R. H. St. John, 10.12.1903 (MEL); Lower Glenelg River, J. H. Willis, 29.12.1948 (MEL); Christmas Hills, North

of Melbourne, Helen I. Aston No. 563, 2.12.1959 (MEL); Fern Tree Gully near Melbourne, H. Salasoo No. 1736, 2.1.1959 (NSW 47353). *Tasmania*: Between Lake Sorrell and Great Lake, HJ. Eichler No. 16554, 10.1.1960 (AD 96107197); Nugent, N. end of Tasman Peninsula, R. Carolin No. 1836, 10.2.1960 (SYD); Prosser River, R. Carolin No. 1846, 10.2.1960 (SYD); Recherche Bay, Cockle Creek, R. Carolin No. 1405, 21.1.1960 (SYD); Gunn, Nos. 259 et 1035 (K) Ironstone, F. A. Rodway, 12.1900 (NSW 42647); J. Milligan, No. 446 (BM); Hobarton, James Backhouse No. 243, 1834 (BM). *A.C.T.*: Near Mt.



Southern Pacific Oblique Azimuthal Equidistant centred on c. long. 180° lat. 51°.

Fig. 3. Map to show the distributional tract of *G. potentilloides*, *G. magellanicum*, and related species.

Franklin, N. T. Burbidge No. 1735, 8.3.1947 (CANB 13052). *New South Wales*: Scout's Alley, Barrington Tops, R. Carolin No. 480, 13.4.1958 (SYD); Mt. Irvine, R. Carolin No. 604, 20.11.1958 (SYD); 10 miles S.E. of Nowendoc, R. Carolin No. 2063, 19.12.1960 (SYD); Point Lookout, R. Carolin No. B122, 19.3.1957 (SYD); Katoomba, J. H. Camfield, 1908 (NSW 42604). *New Zealand*: Picton, South Island, ex. Herb. Kirk No. 319 (BM); Whangarei, D. Petrie, Nov. 1900 (WELT 30893); Fautham Peak, Mt. Egmont, W. R. B. Oliver, 2 Jan. 1937 (WELT 6050); near Putaruru, Mata Mata Co., D. Petrie, March 1915 (WELT 30892); Te Akatea, Raglan Co., D. Petrie, 16th Jan. 1922 (WELT 30895); Tongariro, A. G. Whitehorn, Summer 1907 (WELT 30902); Signal Hill, Dunedin, D. Petrie, Jan. 1891 (WELT 30890); Mason Bay, Stewart Island, J. W. Murdoch, sine date (WELT 30901); Camp site Route to Irene Saddle, Mrs. M. Cookson, Jan. 1955 (CHR 96281); Campbell Island, W. B. Brockie, 4 Jan. 1947 (CHR 30919); Tauheren Kau, Wellington, L. B. Moore, 7.2.1942 (CHR 44656); Karioti National Park, H. L. Poole, 3.2.38 (CHR 19332). *New Guinea*: Andabare, McNicoll Plateau S.W. of Laiagam, R. G. Robbins No. 3336a, Aug. 22.1960 (CANB 88962); Northern Slopes of Sugarloaf complex, Wabag subdistrict, Western Highlands, R. D. Hoogland and R. Schodde No. 7215, 21 July, 1960 (CANB 84255.L.LAE); Eastern Highlands Distr., near Lake Aunde, E. Slope of Mt. Wilhelm, R. D. Hoogland and R. Pullen, No. 5708, 21 July, 1956 (CANB 41150.L.LAE);

Eastern Highlands Distr., Mt. Wilhelm east slopes, L. J. Brass NO. 30183, June 27, 1959 (CANB 101723).

var. *ADDITUM*, var. nov.

Herbae perennes adscendes vel decumbentes. Flores solitaires. Pediceli-pedunculi pilis confertis retrorso-appressis vestiti bracteolisque duo linearis pubescentis infra medium vel base. Rostrum 9–12 mm. longum. Semina oblong nigra alveolis elongatis.



Fig. 4. Distribution of *G. potentilloides* var. *additum* (●), and *G. graniticola* (X).

Ascending or decumbent perennial herb. Flowers solitary. Pedicel-peduncles densely covered with retrorse-appressed hairs, the two linear bracteoles inserted at the base or in the lower half. Rostrum 9–12 mm. long. Seeds oblong, 2 mm. long, 1 mm. wide, black with deep elongated alveolae somewhat larger than those of the other two varieties.

Range. Eastern Highland of Australian mainland.

Habitat. In or on the margin of subalpine woodland.

Typification. Holotype—Munyang near Guthega, R. Carolin, No. 785, 21.1.1959 (NSW 66125). Named from having been concealed to date.

Discussion. It seems probable that this variety forms hybrids with *G. sessiliflorum* in the field. Many of the collections from the Kosciusko plateau appear to be the result of extensive crossing. One particular specimen, i.e., Carolin No. 799, corresponds almost exactly to an artificial first generation hybrid raised by this author. The actual extent of the crossing is not known as yet, but the two species do seem to remain distinct. The present variety is distinguished from *G. sessiliflorum* most easily by the longer flowering stems and deep alveolae on the seed coat; from *G. potentilloides* by the black seeds with deep alveolae and the finer indumentum and the lower placed bracteoles. It seems to connect this group with the sect. *Andina*.

Selected Specimens examined: Victoria: Mt. Buffalo, R. H. Cambage, No. 3731, 19.1.1913 (SYD); Mt. Buller, R. Carolin, No. 1097, 5.1.1960 (SYD). New South Wales: Charlotte's Pass, Mt. Kosciusko, R. Carolin, No. 786, 25.1.1959 (SYD); Island Bend, M. Woodward 21.1.1958 (SYD); White's River Hut near Guthega, R. Carolin, No. 796, 26.1.1959 (SYD); Kanangra Walls, Kanangra Creek, R. Carolin No. 889, 22.3.1959 (SYD); Happy Jack River gorge, J. G. Milmer, 16.2.1957 (NSW 42565).

var. *ARDJUNENSE* (Zoll. et Mor.), comb. et stat. nov.

Nomenclatural Synonym. *G. ardjunense* Zoll. et Mor. in *Nat. en Geneesk. Arch. Ned. Ind.*, 2: 585 (1845); Knuth, *Pflrch. Geran.*, 15 (1912). BASINYM.

Sepal hairs long and stiff and often more or less divergent, especially towards the margins. Leaves with laminae reniform in outline, the main lobes further divided into linear secondary lobes. Bracteoles lanceolate. Rostrum 10-14 mm. long.

Range. Java, Sumatra and Celebes.

Habitat. Mountain forest.

Typification. Types: Zollinger No. 2246 (P.GEN.BO.B, destroyed).

Specimens examined. *Java:* Lawoe, J. H. Coert No. 994 12.1936 (L); G. Lawoe, J. H. Coert No. 336 15.3.1925 (L), C. A. Backer No. 37198, 7.6.1929 (L); G. Kembar, C. Skottsberg and C. A. Backer No. 37199 9.6.1929 (L); G. Merbaboe, J. H. Coert No. 119 22.4.1920 (L); G. Kawi, Oro-oro, Drs. van Leuwen-Reynvaan No. 12330, 17.4.1929 (L.BO); Besoeki, Jang Plateau, van Steenis No. 10921, 15.7.1938 (L.BO); G. Lawoe, J. Dorgeb, Saranga No. 464, Nov. 1924 (L); Pasoercean Mt. Welirang, van Steenis No. 7055, 4.6.1935 (L.BO). *Sumatra:* Atjeh, Laut Poependji, van Steenis No. 6400, 3-5.9.1934 (L.K.BO). *Celebes:* Gg. Bonthain, H. A. B. Bunnemejer No. 12388, 21.6.1921 (L.BO); Gg. Bonthain, H. A. B. Bunnemejer No. 12319, 19.6.1921 (L.BO); G. Bonthain, C. Monod de Froideville No. 229, 1938 (L.BO.K.P.BM). *Timor:* Huato-Builico, N.W. of Mt. Tata-Mailau, van Steenis No. 18378, 4.1.1954 (L.BO.K.COI); Mt. Tatamailau, van Steenis, No. 18444, 5.1.1954 (L.BO.K.COI); Forbes No. 3818, 1897 (BO); Moetis (de Voogd, No. 2272, 14.2.1935 (BO). Huata-Builico, Jaldas do Tata-Mailau, Ruy Cinatti No. 4 (COI).

Discussion. This variety shows some resemblance to *G. nepalense* Sweet. The flowers of this latter species, however, are twinned, it has a much thinner rootstock, and the secondary lobes of the leaf are more towards the base of the primary lobes and more acute. The seed form is very similar indeed, although the indumentum tends to be more villous and spreading in *G. nepalense*. The Celebes specimens are closer to var. *potentilloides* in leaf-shape but they still have the typical sepal-indumentum of var. *ardjunense*; the flowers of the latter are, moreover, smaller than those of the Java specimens which latter are consistently larger than in the type variety.

The specimens collected on Timor show a certain amount of variation in the arrangement of the flowers either solitary or in pairs. Moreover the roots appear to be, in general, thicker than those from Java and the seed alveolae are rather coarser. However, they appear to belong here although showing some resemblance to *G. retrorsum*.

8. GERANIUM MONTICOLA Ridley in *Trans. Linn. Soc. Lond. Bot.*, 9: 23 (1916).

Taxonomic Synonyms. *G. papuanum* Ridley, *loc. cit.*, 23; *G. clemensiae* Knuth in *Fedde Rep.*, 45: 61 (1938); *G. papuanum* var. *alpestris* Ridley, *loc. cit.*, 23.

Perennial herbs, often very compact, with thick ascending, often much-branched, caulorrhiza covered with persistent petioles and stipules. *Flowering stems* prostrate, stoloniferous or very short and ascending, frequently producing secondary erect caulorrhiza at the nodes, pubescent with very short hairs at least when young. *Leaves:* laminae usually reniform in outline, hirsute, particularly on the undersurface, or almost glabrous, deeply 3-5-lobed or dissected, 3-7 mm. long, 12-14 mm. wide, the lobes sometimes toothed towards the apex; petioles covered with retrorse-appressed hairs, c. 5-6 cm. long; stipules ovate to orbicular, 3-2.5 mm. long, 3-3.5 mm. wide, pubescent, membranous, brown. *Flowers* solitary, pedicel-peduncle pubescent with soft retrorse-appressed hairs, 2.5-5 mm. long; bracteoles ovate to orbicular, c. 2 mm. long, usually obtuse or very slightly acuminate, more or less pubescent, membranous, brown. *Sepals* elliptic to oblong, c. 3 mm. long, 1 mm. wide, pubescent with soft appressed hairs sometimes divergent at the apex with a short mucro. *Petals* spatulate, distinctly unguulate, 1.5-4 mm. long, 2-4 mm. wide, glabrous towards the base, pink. *Stamens* 10; filaments lanceolate, c. 3 mm. long, ciliate, bearing a sub-globular anther, the outer whorl sometimes with two teeth on the shoulders. Mericarp and seeds not seen.

Range. New Guinea.

Habitat. Alpine grasslands and rocky outcrops.

Typification. *G. monticola* Ridley—Holotype—Camp XIII, Mt. Carstensz, 10500 ft. (BM); *G. papuanum* Ridley—Holotype—Camps X–XI, Mt. Carstensz, 6700–8300 ft. (BM); *G. clemensiae* Knuth—Holotype—Mt. Sarawaket, auf dem Gipfel, Clemens No. 5872, 1937 (B destroyed) (no further specimens have been traced); *G. papuanum* var. *alpestris* Ridley—Holotype—Camps XIII–XI, Mt. Carstensz, 8300–10500 ft. (BM. K. isotype).

Discussion. Variable, particularly in the degree of hairiness of the leaves. *G. papuanum* is based upon a more glabrous specimen, *G. monticola* on one which is hirsute, particularly on the undersurface of the leaf. There seems to be every gradation between these two extremes. At higher altitudes the plants have a more compact habit—the basis for *G. papuanum* var. *alpestris*; again there seem to be gradations linking the normal form and the more compact one. It has not been possible to trace type material of *G. clemensiae*, but from the rather inadequate description of Knuth it appears that it belongs here.

This species appears to be another upland derivative of *G. potentilloides*, differing from the latter species in the smaller, usually less dissected, leaves, compact habit or producing secondary caulorrhiza at the rooting nodes of the stolons, ovate-orbicular and imbricate bracteoles and distinctly clawed petals which are glabrous on the margin at the base.

Specimens examined: New Guinea: 11 km. north-east of Wilhelmina Top, 3400 m. alt., L. J. Brass and E. Meyer-Drees, No. 9813, Sept. 1938 (L.); 2 km. east of Wilhelmina Top, 3800 m. alt., L. J. Brass and E. Meyer-Drees No. 10186, Sept. 1938 (L.); Lake Habbema, L. J. Brass, No. 9207, Aug. 1938 (L.); Meer-bir, G. Versteeg, No. 2494, 17.2.1913 (L.B.O.); 7 km. north-east of Wilhelmina Top, L. J. Brass and E. Meyer-Drees, No. 9868 Sept. 1938 (L.); Oranje Mts., G. Versteeg, No. 2527, 1912 (BO); Mt. Gilume, Southern Highlands Distr., R. Schodde No. 1946, 21.8.1961 (CANB 106990. LAEL.BM.BRI); Mt. Wilhelm, Eastern Highlands Distr. R. G. Robbins No. 1282, 20.8.1957 (CANB) 46127).

9. GERANIUM TRAVERSII Hook. f., *Handbk. N. Zeal. Fl.*, 726 (1867); Kirk, *Stud. Fl. N. Zeal.*, 80 (1900); Knuth *Pflrch. Geran.*, 151 (1912); Allan, *Fl. N. Zeal.*, 1: 236 (1961).

Unrecognized variety: *G. traversii* var. *elegans* Chn. in *Trans. N. Zeal. Inst.*, 34: 320 (1902); Allan, *Fl. N. Zeal.*, 1: 237 (1961).

Perennial herb with a strong but not napiform tap-root and a thick more or less erect and branched caulorrhiza covered with persistent petioles and stipules. *Flowering stems* decumbent or ascending to 50 cm. long, much branched, pubescent with soft retrorse-appressed hairs, sometimes rooting at the nodes. *Basal leaves* larger than the cauline ones but otherwise similar. *Cauline leaves* opposite; laminae grey-green, reniform to orbicular in outline, 12–25 mm. long, 15–50 mm. wide, pubescent with soft grey appressed hairs, rather more densely so on the undersurface, deeply 5–7-lobed or dissected, the lobes obovate or obcuneate terminated by 3–5 more or less obtuse secondary lobes or teeth; petioles up to 5 cm. long, densely pubescent. *Flowers* solitary; pedicel-peduncle 3–6 cm. long, covered with soft retrorse-appressed hairs, with two linear-lanceolate acuminate bracteoles 3–4 mm. long at or below the mid-mark, swelling in the upper parts in the fruiting condition. *Sepals* ovate-elliptic to oblong, 9–10 mm. long, 3–4 mm. wide, softly pubescent with short dense appressed hairs, more or less flat in the fruiting condition and with a mucro about 1 mm. long, margin more or less membranous and ciliate. *Petals* obovate, 10–11 mm. long, 6–8 mm. wide, white or pink, entire, ciliate near the base. *Stamens* 10; filaments lanceolate, 4–5 mm. long, 0.5 mm. wide, ciliate; anthers sub-globular. *Ovary* villous-hirsute; stigmata yellow (?), c. 1.5 mm. long. *Fruit:* mericarps oblong, c. 4 mm. long and 1.5 mm. wide, covered with soft hairs; funicular hairs villous, 40–50; awns densely pubescent; rostrum 12–14 mm. long. *Seeds* oblong, 2.5 mm. long, 1–1.5 mm. wide, dark brown with shallow elongated alveolae and a lateral raphe.

Range. Endemic on the Chatham Islands.

Habitat. Coastal cliffs.

Typification. Holotype—Chatham Island, Travers No. 25 (K).

var. *elegans*—no type cited.

Discussion. A well-defined endemic species occupying a specialized habitat on the Chatham Islands. The indumentum and seed coat indicate a fairly close affinity with *G. potentilloides*. It differs from the latter species in the denser silvery-grey indumentum, larger flowers (2 cm. diam. when open) and a thicker, stronger caulorrhiza.

Specimens examined: Chatham Islands: Chatham Is. F. A. D. Cox, 1903 (K); Cultivated at Dunedin, H. Matthews (K); ex Herb. T. F. Cheeseman, coll. H. Matthews (K); Chatham Islands, F. A. D. Cox, 1901 (WELT 30950); Red Bluff, W. R. B. Oliver, 6.12.1909 (WELT 6071); Flowerpot, Pitt Island, B. G. Hamlin No. 675, 31.1.1957 (WELT 3315); Le Whanga Lagoon Flying Boat Base, N. T. Moar No. 1528, 5.11.1959 (CHR 97889).

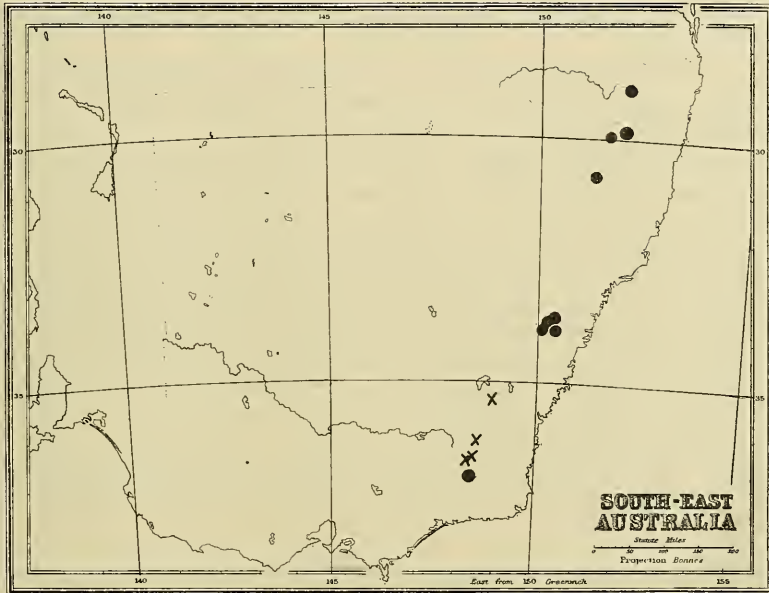


Fig. 5. Distribution of *G. neglectum* (●), and *G. obtusisepalum* (X).

10. GERANIUM NEGLECTUM, sp. nov.

Herbae decumbentes caulibus longis rubris floriferibus. Flores solitarii, pedicellus pedunculusque ad 10 cm. longus bracteolis mediis pilisque retrorso-appressis. Petala 14 mm. longa, 7 mm. lata. Rostrum 15 mm. longum semina fusca reticulatis parvissimis.

Decumbent or prostrate perennial herbs ascending only when supported, with a thick but not napiform tap-root and thick short (usually less than 3 cm.) more or less woody caulorrhiza bearing dead stipules and leaf bases. Flowering stems terete, reddened, up to 120 cm. long, often much branched, bearing a few closely appressed hairs or almost glabrous, often rooting at the nodes. Basal leaves larger than cauline ones but otherwise similar. Cauline leaves opposite; petioles slender, 2.5–7 cm. long, covered with closely retrorse-appressed hairs; laminae orbicular to reniform in outline, 1–3 cm. long, 2.5–4 cm. wide with scattered appressed hairs on both surfaces, although more concentrated on the veins of the paler lower surface, deeply palmately 5–7-lobed; lobes obovate to oblong, further divided into 2–5 mucronate secondary lobes; stipules membranous, long-deltoid or lanceolate-acuminate, 4–6 mm. long, 1–2 mm. wide, ciliate and with some scattered villous hairs towards the base. Flowers solitary; pedicel-

peduncle slender, up to 10 cm. long, sparsely covered with retrorse-appressed hairs becoming thicker towards the top, and with two linear herbaceous almost glabrous bracteoles c. 3 mm. long at about the mid-point, swelling in the upper parts in the fruiting condition. *Sepals* lanceolate to narrow-elliptic, 6–9 mm. long, 2–2.5 mm. wide, with scattered appressed hairs, more or less flat in the fruiting stages; margin broad, membranous, ciliate. *Petals* obovate, c. 14 mm. long and 6 mm. wide, pink becoming white towards the base and with darker veins, ciliate on the margin towards the base. *Stamens* 10; filaments lanceolate-acuminate, c. 6 mm. long and 0.5 mm. wide, pale yellow to white, ciliate surmounted by an oblong anther about 1 mm. long; pollen yellow. *Ovary* hirsute-villous; stigmata yellow, c. 2.5 mm. long. *Fruit*: mericarp oblong, 4 mm. long, 2 mm. wide, very dark brown covered with short stiff hairs, especially above, and some minute glandular ones, funicular hairs c. 25; awns covered with more or less appressed hairs and some minute glandular ones; rostrum c. 15 mm. long. *Seeds* dark brown, oblong, 3 mm. long, 1.5 mm. wide covered with very small almost isolateral alveolae, raphe lateral.

Range. Eastern Highlands; so far known as far north as Queensland–New South Wales border.

Habitat. Swamps and on creek banks, probably mainly in granite areas.

Typification. Holotype—Banks of the Boyd River, Jenolan-Kanangra. R. C. Carolin No. 916, 23.3.1959 (NSW 66124).

Discussion. The closest affinities of this species seem to lie with *G. potentilloides*, from which it can be distinguished by the larger flowers, longer pedicel-peduncle and finer reticulations on the seed coat. It also has a very distinctive habitat.

Specimens examined: *Victoria*: Delegate River Bridge, Bidwell, J. H. Willis, 18.1.1948 (MEL); *New South Wales*: Clarence River, H. Beckler (MEL); New England, C. Stuart (MEL); Timbarra, C. Stuart (MELB); Mt. Werong, R. H. Cambage No. 3177, 4.12.1911 (NSW 42607); W. A. Dixon, without date (NSW 42571); Torrington near Deepwater, H. Deane, 3.1906 (NSW 42585); Below Camp, Manning River, E. F. Riek No. 028, 6.4.49 (CANB 21436); *Queensland*: Wallangarra, J. L. Boorman, 5.1914 (NSW 42584).

11. GERANIUM OBTUSISEPALUM, sp. nov.

Radix princeps tuberosus. *Pedunculus* uniflorus. *Pedicellus* pedunculusque pilis patenti-retrorsis brevibus vestiti et medio bracteoles parvo lineari-deltaideo ferentes. *Sepala* late ovata obtusa vel mucroni obtuso brevissimo munita. *Semina* fusca obscure reticulata.

Decumbent or ascending perennial herbs with a very short erect caulorrhiza covered with persistent leaf bases and stipules and with a napiform tap-root. *Flowering stems* obscurely angled or terete, decumbent or ascending, up to 30 cm. long, thickly covered with short soft hairs and some longer villous ones. *Basal leaves* similar to the cauline ones but larger. *Cauline leaves* opposite; petioles 1–6 cm. long, densely pubescent; laminae orbicular to reniform in outline, 1–2 cm. long, 1–3 cm. wide, hirsute on both surfaces, deeply palmately 5–7-lobed, the lobes obovate and mostly divided into three obtuse secondary lobes towards the top; stipules linear-lanceolate, acuminate, 3 mm. long, 1 mm. wide, pubescent, ciliate with long hairs. *Flowers* solitary; pedicel-peduncles 2–4 cm. long, pubescent with upper hairs often retrorse appressed, geniculate at the bracteoles and becoming swollen in the upper part as the fruit matures, with a pair of linear pubescent bracteoles at about the mid-point. *Sepals* elliptic to oblong, 5–7 mm. long, 3–4 mm. wide, pubescent or hirsute, obtuse or with a very short blunt mucro; margin membranous and ciliate. *Petals* obovate, c. 6 mm. long and 3 mm. wide, emarginate or 3-toothed at the apex, ciliate towards the base, pink but paler towards the base. *Stamens* 10; filaments linear-lanceolate, c. 3.5 mm. long and 0.5 mm. wide, almost glabrous, ciliate at the margin surmounted by a more or less globular anther; pollen white to pale yellow. *Ovary* hirsute; stigmata green to white or very pale pink, 1.5 mm. long. *Fruit*: mericarp covered with coarse simple hairs and small glandular ones above, ovoid, 3 mm. long, 2 mm. wide, brown, funicular hairs mostly erect and

c. 25; awns covered with antrorse simple and numerous much smaller glandular hairs on the outer surface; rostrum 10–14 mm. long. *Seeds* ovoid, dark brown with small obscure alveolae, 2 mm. long, 1.5 mm. wide, raphe lateral.

Range. South-east of the Australian mainland.

Habitat. Montaine and sub-alpine woodland (probably more extensive).

Typification. Holotype—Munyang near Guthega, R. Carolin No. 783, 25.1.1959 (NSW 66126).

Discussion. A distinct species with a restricted distribution. It is unique amongst the Eastern Australian representatives of this group in having a swollen napiform tap-root and obtuse sepals.

Selected Specimens examined: New South Wales: Kiandra, New Chum Mine, R. Carolin No. 758, 21.1.1959 (SYD); Kosciusko hotel dam, R. Carolin, No. 779, 21.1.1959 (SYD); above Sawpit Creek, M. Woodward, 21.1.1958 (SYD); Yarrangobilly Caves, R. Carolin No. 762a, 21.1.1959 (SYD); Upper Tumut River near Junction Shaft, J. G. Filmer, 16.2.1957 (NSW 42564). *A.C.T.:* Ski run, Mt. Franklin, N. T. Burbidge No. 1670, 6.2.1947 (CANB 13003); Mt. Franklin Hut, R. Pullen No. 97, 15.3.1958 (CANB 53519).

12. GERANIUM GRANITICOLA, sp. nov.

Herbae decumbentes. Caulis pilis pubescentibus retrorsis vestiti. Flores solitaires. Bracteolae circa medium pedicellus pedunculusque pubescentis. Sepala saepe reflexa ad maturitatem fructus. Petala alba. Semina nigra alveolis prominentibus longis.

Weakly ascending or decumbent perennial herbs with thick but not napiform tap-roots and short branched caulorrhiza covered with dead stipules and leaf bases. *Flowering stems* up to 50 cm. long, frequently rooting at the nodes, terete or somewhat compressed, puberulent with short patent or very slightly retrorse hairs. *Basal leaves* similar to cauline leaves but larger. *Cauline leaves* opposite; petioles slender, up to 20 cm. long, puberulent; laminae reniform to semi-orbicular in outline, somewhat cordate at the base, up to 30 mm. long and 40 mm. wide, deeply palmately 5–7-lobed, each lobe obovate and with 3–5 secondary lobes towards the top, pubescent on both surfaces. *Flowers* solitary: pedicel-peduncle pubescent with retrorse-spreading hairs, 2–4 cm. long with two linear, membranous to sub-herbaceous pubescent ciliate bracteoles just below the mid-mark, geniculate at the bracteoles and swelling towards the top at maturity. *Sepals* lanceolate to elliptic or oblong, c. 4 mm. long, 1–2 mm. wide, pubescent, acute to acuminate with a short mucro, membranous and ciliate at the margin, frequently reflexed in the fruiting stages. *Petals* obovate, c. 5 mm. long and 3.5 mm. wide, entire or undulate at the apex, white, ciliate on the margin towards the base. *Stamens* 10; filaments membranous, lanceolate, long-acuminate, up to 4 mm. long, sparsely ciliate at the margin; anthers oblong, 0.5 mm. long, yellow with purple dehiscence lines. *Ovary* hirsute-villous; stigmata white, c. 1 mm. long. *Fruit:* mericarps oblong, 3 mm. long, 1 mm. wide, covered with short spreading hairs and minute glandular ones, specially towards the top, funicular hairs c. 20; awns covered with very short simple hairs and minute glandular ones on the outer surface; rostrum 9–11 mm. long. *Seeds* black, oblong, 2.5 mm. long, 1.5 mm. wide, covered with prominent elongated reticulations, minutely punctulate, raphe lateral.

Range. Central Tablelands of New South Wales.

Habitat. High altitude woodlands, usually on soils derived from granite.

Typification. Holotype—Oberon, R. Carolin, No. 919, 23.3.1959 (NSW 66128). Named from its usual habitat on soils derived from granitic rocks.

Discussion. A species with a very small distribution, but, nevertheless, quite distinct. It shows affinities with *G. potentilloides* var. *abditum*, from which it differs in the retrorse-spreading hairs, the sepals divergent in the fruiting stages, the white petals, and the somewhat different shape of the alveolae of the seed coat. These two taxa have been observed growing in the field together but no intermediates have been found, although these have been sought.

Specimens examined: New South Wales: Duckmaloi River S. of Oberon, R. Carolin, No. 877, 21.3.1959 (SYD); Kanangra Walls, R. Carolin, No. 888, 22.3.1959 (SYD); Lowther-Jenolan, R. Carolin, No. 877, 21.3.1959 (SYD); Jenolan Caves valley, R. Carolin, No. 883, 21.3.1959 (SYD).

13. *GERANIUM HOMEANUM* Turcz. in *Bull. Soc. Imp. Nat. Hist. Soc. Mosc.*, 36: 591 (1863).

Taxonomic Synonyms. *G. parviflorum* Willd., *Enum. Hort. Berol.*, 716 (1809) non Curtis $\equiv$ *G. potentilloides* var. *parviflorum* (Willd.) Hook. f., *Fl. Tasm.*, 1: 57 (1860); *G. dissectum* var. *glabratum* Hook. f., *Handbk. N. Zeal. Fl.*, 36 (1864) $\equiv$ *G. glabratum* (Hook. f.) Small ex Hanks et Small in Underwood-Britton, *N. Amer. Fl.*, 25: 10 (1907).

Misapplied Names. *G. australe* (non Nees in Lehm.) Allan, *Fl. N. Zeal.*, 1: 233 (1961).

Annual or perennial herbs with thick fleshy but not napiform tap-roots which may be much branched, and very short caulorrhiza covered with persistent stipules and leaf bases. *Flowering stems* decumbent, ascending only when supported, much branched, up to 70 cm. long but usually about 30 cm., sparsely covered with coarse retrorse hairs or sometimes almost glabrous. *Basal leaves* similar to cauline ones only larger. *Cauline leaves* opposite; petioles covered with coarse retrorse hairs, up to 5 cm. long; laminae palmately 3-5-lobed, semi-orbicular to reniform in outline, 2-4 cm. long, 3-5 cm. wide, with scattered coarse appressed hairs on either side; lobes oblong-obovate, usually divided into three secondary lobes or deep teeth with more or less mucronate tips near the top; stipules linear-lanceolate, to linear-deltoid, 3-6 mm. long, 0.5-1 mm. wide, acuminate, membranous, brown, ciliate and with coarse appressed hairs on the lower surface, especially towards the midrib or glabrous. *Flowers* usually borne in pairs; peduncles 1.8-2.4 cm. long; bracteoles linear, 3 mm. long and c. 0.5 mm. wide, almost glabrous on the surfaces but ciliate at the margin; pedicels 1.5-2.2 cm. long, covered with coarse retrorse-appressed hairs becoming denser towards the top and more or less divergent above in the fruiting condition, geniculate at the bracteoles and swelling above in the fruiting condition. *Sepals* elliptic to oblong, 4-5 mm. long, 1.5-2.0 mm. wide, sparsely covered with coarse appressed hairs and some smaller ones; margin membranous, minutely denticulate or entire. *Petals* pale pink to almost white, broad-oblongate to obovate, 2-4 mm. long, c. 1.5 mm. wide, entire at apex, ciliate towards the base. *Stamens* 10; filaments lanceolate-acuminate, c. 2.5 mm. long, 0.5 mm. wide, ciliate but not dentate; anthers reniform to orbicular, white with purple dehiscence lines. *Ovary* hirsute; stigmata green, 1 mm. long. *Fruit:* mericarps covered with coarse often divergent hairs with a few minute glandular ones towards the top, ovoid, 3 mm. long, 2 mm. wide, funicular hairs 20-30; awns covered with short antrorse hairs and some minute glandular ones on the outer surface; rostrum 8-11 mm. long. *Seeds* dark brown, ovoid, c. 2.5 mm. long, covered with shallow elongate alveolae with a lateral raphe.

Range. Eastern Australia, coastal plains and lower parts of the Dividing Range; New Zealand, Java, and introduced into California.

Habitat. Usually in damp places on fairly good soils.

Typification. *G. homeanum* Turcz.—Holotype—Everard Home, Nova Zealandia loco dicto Perakiteri, No. 86 (KIEW. photo SYD. K); *G. parviflorum* Willd.—Syntypes—two sheets in Willdenow's herbarium (B. photo K.); *G. dissectum* var. *glabratum* Hook. f. There are no specimens at Kew labelled as such, but some labelled "*G. carolinianum*" correspond to the description and it seems that Hooker considered *G. carolinianum* as some sort of super-variety since it is printed in bold-face type in the Handbook; one of these specimens is selected as the lectotype—New Zealand, Edgersley (K).

Discussion. A species of warm temperate areas and generally damp environments, being quite common on the margins of subtropical rain forests of the eastern coast of Australia. It can be distinguished from *G. potentilloides* by the twinned, usually smaller flowers, coarser and usually sparser hairs on the pedicels which in the former tend to become divergent in the fruiting condition, and the broader larger alveolae of the

seed-coat. It differs from *G. retrorsum* in the indumentum being sparser and less appressed in the fruiting condition particularly, non-napiform tap-root, narrower leaf-lobes or segments, narrower alveolae of the seed-coat, and the usually longer sepal awns. From *G. solanderi* it differs in the non-napiform root, more appressed hairs and narrower alveolae of the seed-coat.

The Australian and Javanese specimens have smaller flowers than most of the New Zealand ones and those from the more northerly part of the Australian range (as known at present) have very short awns on the sepals. The Javanese specimens

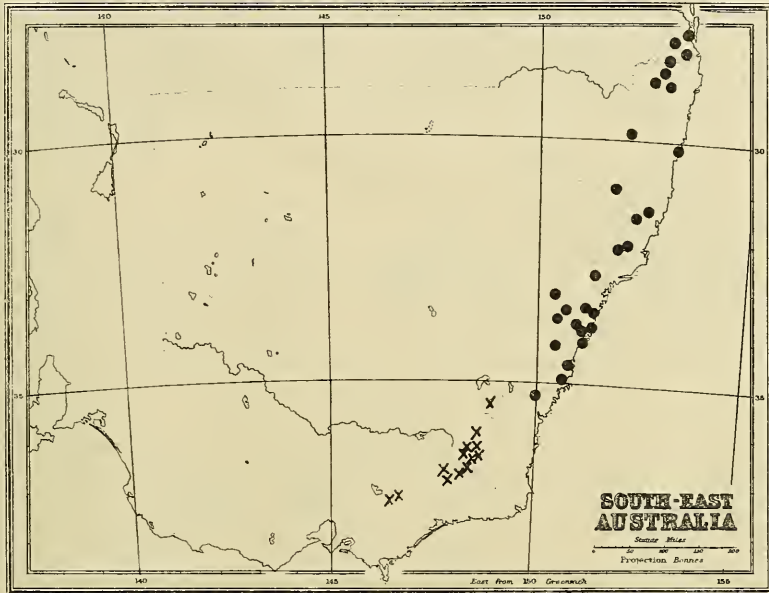


Fig. 6. Distribution of *G. homeanum* (●), and *G. antrorsum* (X).

do not seem to differ at all from those of eastern Australia. They have been referred to *G. nepalense* Sweet in the past, but differ from that species in the coarser alveolae of the seed-coat, obtuse leaf-lobes which are only toothed near the top, smaller flowers, more vigorous, decumbent stems. It is surprising that this species has so far not been collected in the montane forests of New Guinea, although it is just possible that it is not native in Java.

Selected Specimens examined: *New South Wales:* Bungonia Caves, R. Carolin No. 842, 1.3.1959 (SYD); Nowra, F. A. Rodway No. 14720, 26.3.1948 (NSW 42673); Byrne's Gap, Yerranderie-Kowmung River, L. A. S. Johnson 26.3.1948 (NSW 5017); Glenbrook Gorge, H. S. McKee No. 6770, 4.1.1959 (SYD); Garie Beach, Royal National Park, R. Carolin No. 940, March, 1959 (SYD); Port Jackson, R. Brown, No. 5224 (BM); Nova Cambria, Botany Bay, Banks and Solander (BM); Dee Why, Canon Michael No. 2061, 19.12.1960 (SYD); Curtis Creek nr. Grafton, R. Carolin No. 0767, 2.1.1959 (SYD); *Queensland:* Mt. Lindsay, R. Carolin No. 944, 31.5.1959 (SYD); Lamington National Park, R. Carolin No. 1046, 4.6.1959 (SYD); Ithaca Creek, C. T. White, Nov. 1913 (BRI 037048, NSW 42617); Ferny Grove nr. Brisbane, L. S. Smith (BRI 037049). *Java:* Tengger, M. Buysman, 8.11.1908 (LBO); Ngadiwana, C. A. Backer, No. 8403, 1913 (LBO). *New Zealand:* Onehunga, North Island ex herb. Kirk No. 232 (K); Reef Point, N. Auckland, H. H. Allan, 9.1.1932 (CHR 4358); Whangarei, A. J. Healy, 28.5.1950 (CHR 84329B); Mount Smart, T. Kirk No. 642, Jan. 6.1866 (WELT 30988); Mt. Wellington Lava field, Auckland, D. Petrie, Dec. 1914 (WELT 30984B); Kikurangi N. of Whangarei, D. Petrie, March 1898 (WELT 30983).

GROUP IV. Perennials usually with napiform tap-roots. Flowers twinned (very rarely solitary and then only some on each plant). Pedicels geniculate, swollen above in the fruiting stages. Flowering stems long. Seeds black or sometimes very dark brown with coarse more or less isolateral alveolae. (= Sect. *CHILENSIA* Knuth, but see in discussion.)

14. *GERANIUM RETRORSUM* L'Hér. ex DC., *Prodr.*, 1: 644 (1824); Hanks et Small in Underwood-Britton, *N. Amer. Fl.*, 25: 10 (1907); Munz, *Calif. Fl.*, 141 (1959).



Southern Pacific Oblique Azimuthal Equidistant centred on c. long. 180° lat. 51°.

Fig. 7. World distribution of *G. homeanum*.

Nomenclatural Synonyms. *G. patulum* Sol., *Prim. Fl. N. Zeal.*, msc. non Sol. in Forst. f., *Prodr.*, 91 (1796) *nom. nud.*; *G. dissectum* var. *patulum* Hook. f., *Handbk. Fl. N. Zeal.*, 36 (1864); *G. pilosum* var. *grandiflorum* Knuth *Pfirs.-Geran.*, 75 (1912) *nom. superfl.*; *G. pilosum* var. *retrorsum* (L'Hér. ex DC.) Jepson, *Man. Calif. Pl.*, 588 (1926).

Taxonomic Synonyms. *G. australe* Nees in Lehm., *Pl. Preiss.*, 1: 162 (1844) *non* (Willd.): Poir., *Encycl. Suppl.*, 2: 754 (1811) $\equiv$ *G. pilosum* var. *australe* (Nees in Lehm.) Ostenf. in *Dansk. Vid. Selsk. Biol. Medd.*, 3: 71 (1921).

Perennial herbs with swollen napiform tap-root and short thick caulorrhiza frequently covered with dead stipules and leaf-bases. Stems decumbent or ascending, up to 40 cm. long, covered with short soft retrorse appressed hairs, glabrescent below. Basal leaves similar to cauline ones but larger and somewhat more deeply dissected. Cauline leaves opposite; petioles covered with short soft retrorse appressed hairs, 2-7 cm. long, laminae ovate to orbicular or reniform in outline, 1-2 cm. long, 1.5-3.0 cm. wide, deeply palmately (3)5-7-dissected or lobed, each segment or lobe divided into three narrow more or less acute secondary lobes, covered with appressed hairs on both surfaces; stipules membranous, brown, lanceolate to narrow-deltoid, up to 3 mm. long, covered with soft appressed hairs. Flowers twinned or very rarely solitary; peduncles

densely clothed with soft retrorse-appressed hairs, 6–20 (80) mm. long; bracteoles 4, linear to linear-deltoid, 2–3 mm. long, pubescent, ciliate at the margins; pedicels similar to peduncles, 18–35 mm. long, geniculate at the bracteoles and becoming swollen above in the fruiting stages. *Sepals* elliptic to oblong or ovate, 4–6 mm. long, 3–4.5 mm. wide, densely covered with more or less appressed hairs and with some scattered more or less divergent ones particularly towards the margins, mucronate. *Petals* obovate, 5–10 mm. long and 2–4 mm. wide, pink but paler towards the base with yellowish veins, almost quite entire at the apex or very slightly emarginate. *Stamens* 10; filaments lanceolate-acuminate, 3–4 mm. long, 0.5 mm. wide, ciliate at the margin with long hairs. *Ovary* hirsute; stigmata white or green, c. 1.5 mm. long. *Fruit*: mericarps 2 mm. long, 1.5 mm. wide, covered with coarse often divergent hairs and minute glandular ones towards the top, dark grey, funicular hairs 20–35; awns covered with short antrorse simple hairs and some minute glandular ones on the outer surface; rostrum 8–15 mm. long. *Seeds* black or very dark brown with coarse, usually deep, more or less isolateral alveolae, sub-globular, 2–2 mm. long.

Range. Temperate Australia, New Zealand. Introduced into Hawaiian Islands and California.

Typification. *G. retrorsum* L'Hér. ex DC. Holotype—In Nova Zealandia, Banks and Solander (GEN photo SYD, isotype BM). This name was apparently meant to replace *G. patulum* Sol. which Solander had described in his unpublished flora of New Zealand, but which was unavailable owing to the existence of *G. patulum* Villars, *Hist. Pl. Dauph.*, 1: 283 (1786) (see under *G. solanderi*). *G. dissectum* var. *patulum* Hook. f.—Lectotype—*G. retrorsum* L'Hér. ex DC. Hooker cited the same species in synonymy of this variety as he had previously under *G. dissectum* var. *retrorsum*, i.e., *G. retrorsum* and *G. patulum* "Forst"; it is therefore superfluous in effect if not strictly so according to the Code of Botanical Nomenclature; the lectotype is selected to conform to Hooker's presumed intent, i.e., that he was describing the same variety under two different names. *G. pilosum* var. *grandiflorum* Knuth is superfluous as included in synonymy is *G. dissectum* var. *patulum* Hook. f. which varietal epithet is legitimate and available in *G. pilosum*. *G. australe* Nees in Lehm. non (Willd.) Poir.—Lectotype—part of Preiss No. 1907. Material of this number has been traced to Leningrad; the sheet was kindly lent. There are at least two taxa present on this sheet under the same number. The description clearly applies to only one of these parts, particularly with regard to the indumentum. This specimen has been marked appropriately both on the original sheet (LEN) and on the photograph (SYD).

Discussion. A fairly well-defined and widespread taxon. It is distinguished from *G. solanderi* by the closely appressed indumentum and usually by the much narrower leaf-segments. It grows in association with this latter species but does not appear to hybridize. Some of the South Australian specimens have solitary flowers and resemble *G. potentilloides* very closely; the napiform root, the seed coat alveolae and the presence of long hairs on the margins of the sepals, however, clearly differentiate *G. retrorsum* from *G. potentilloides*.

The description supplied for *G. australe* Nees in Lehm. in Allan, *Fl. N. Zeal.*, 1: 233 (1961), is quite clearly not applicable to any of the elements contained within the type number at Leningrad. It applies to *G. homeanum*, q.v.

It should be noted that some specimens from Western Australia referred here have exceptionally large flowers, e.g., Benger, R. D. Royce, No. 4377, 19.Sept.1953 (K. WA); Bridgetown to Kojonup and Slab Hut Gully, A. A. Dorrien-Smith, 1910 (K). No root systems and no seeds of these specimens, or anything like them, have so far been collected.

Selected Specimens examined: *Western Australia:* Porongurup Ranges, Twin Peaks, R. Carolin, No. 3450, 8.9.1961 (SYD); N.W. of Gnowangerup, B. G. Briggs, 8.10.1960 (NSW. SYD); near Claremont, ex herb. W. V. Fitzgerald, 9.1901 (NSW 42627); Smith's Hill, J. Sheath, 9.1901 (NSW 43648). *South Australia:* Yardea Station, Minnipa, Northern Eyre Peninsular, D. J. E. Whibley No. 405, 7.10.1958 (AD 95931007); Henley Beach

west of Adelaide, E. H. Ising, 13.11.1919 (AD 96117061); Encounter Bay, J. B. Cleland, 13.9.1931 (AD 96117077); Mt. Lofty Range, Max Koch, 9.1902 (NSW 42615). *Victoria*: Mt. Wycheproof, W. W. Watts, Oct. 1917, No. 714 (NSW 42625); Malden, Mrs. Nott (MEL); Ararat, Charl. Green (MEL); 2 miles N. of Kanya, J. H. Willis, 13.9.1960 (MEL). *New South Wales*: Armidale, R. Carolin, No. 0757, 1.1.1959 (SYD); Temora, J. W. Dwyer, 9.1915 (NSW 42697); Bega, F. A. Rodway, 12.1920 (NSW 42679); Bathurst, Peacock, 11.1901 (NSW 42606); Sunny Corner, J. L. Boorman, 11.1899 (NSW 42611). *New Zealand*: Harewood, Christchurch, G. Simpson, sine date (CHR 88013); Cockburn-Hornby district, A. J. Healy, No. 56/185 29.10.1956 (CHR 92182A); Kaituna, Banks Peninsula, A. J. Healy, 20.2.1945 (CHR 62928); Puponga, Manukau Harb. L. Cockayne, No. 833/4, sine date (WELT 31009).

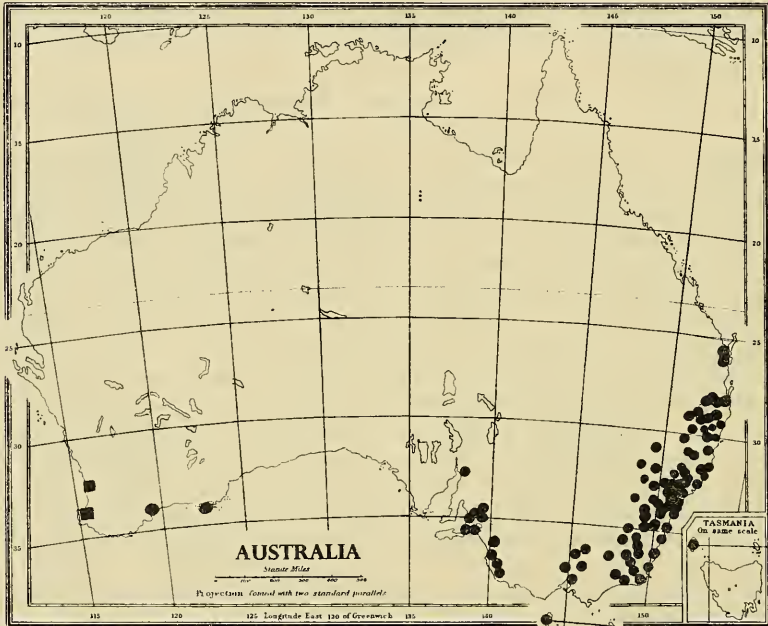


Fig. 8. Distribution of *G. solanderi* (●), and *G. drummondii* (■).

15. GERANIUM SOLANDERI, nom. nov.

Nomenclatural Synonyms. *G. pilosum* Sol. in Forst. f., *Prodr.*, 91 (1786) *non* Cav., *Diss.*, 5: 273 (1788) *nom. nud.* et in *Prim. Fl. N. Zeal.*, msc.; *G. pilosum* Sol. ex Willd., *Sp. Pl.*, 3: 706 (1801) *non* Cav., *loc. cit.*; DC., *Prodr.*, 1: 642 (1824); Sweet, *Geran.*, 2:t.119 (1822-29); Moore et Betche, *Handbk. Fl. N.S.W.*, 55 (1893); Knuth, *Pflrch.-Geran.*, 75 (1912); Jepson, *Man. Fl. Pl. Calif.*, 589 (1926); Ewart, *Fl. Vict.*, 682 (1930); Black, *Fl. S. Aust.*, 2nd ed., 2: 482 (1948); Curtis, *Stud. Fl. Tasm.*, 1: 91 (1956); Munz, *Calif. Fl.*, 141 (1959); Allan, *Fl. N. Zeal.*, 1: 234 (1961); *G. dissectum* var. *pilosum* Hook. f., *Fl. Tasm.*, 1: 57 (1860) et *Handbk. N. Zeal. Fl.*, 36 (1864); *G. dissectum* var. *australe* Benth., *Fl. Austr.*, 1: 296 (1863); Bailey, *Queensland Fl.*, 1: 177 (1899); Rodway, *Tasm. Fl.*, 19 (1903).

Taxonomic Synonyms. *G. patulum* Sol. in Forst. f., *Prodr.*, 91 (1786) *nom. nud.*, *non* Sol. in *Prim. Fl. N. Zeal.*, msc., *nec* Villars, *Hist. Pl. Dauph.*, 1: 283 (1786).

Misapplied names. *G. dissectum* var. *carolinianum* (*non* (L.) Hook. f.) Hook. f., *Handbk. N. Zeal. Fl.*, 36 (1864).

Perennial herbs with napiform or merely thickened tap-roots and short more or less erect caulorrhiza covered with dead stipules and leaf-bases. *Flowering stems* decumbent or more or less ascending, up to 50 cm. long, angular or compressed above but terete

below, covered with coarse retrorse-divergent or patent more or less villous hairs. *Basal leaves* similar to cauline ones but larger and frequently more dissected. *Cauline leaves* opposite; petioles covered with reflexed or patent hairs, up to 5 cm. long; laminae deeply 5-7-lobed, semi-orbicular to reniform in outline, frequently cordate at the base, 1-2.5 cm. long, 1.5-4 cm. wide, with coarse sub-appressed hairs on both surfaces; lobes obovate, divided into 3-5 mucronate to acuminate secondary lobes near the top; stipules sub-herbaceous, lanceolate to narrow-deltoid, 3-9 mm. long, up to 1.5 mm. wide, acuminate, covered with short appressed hairs and ciliate at the margin, rarely almost glabrous. *Flowers* twinned; peduncles 1-4 cm. long, hirsute or villous with reflexed or patent hairs; pedicels 2.5-5 cm. long, geniculate at the base and swollen above in fruiting stages, indumentum as peduncles; bracteoles lanceolate to linear-deltoid, up to 4 mm. long, membranous, villous, ciliate at the margins. *Sepals* elliptic to ovate, 5-9 mm. long, 2-5 mm. wide, acute to acuminate, covered with villous-patent hairs with longer ones at the margins and on the veins usually concave in the fruiting condition; margin membranous and ciliate. *Petals* obovate, 5-12 mm. long, 2-5 mm. wide, entire or emarginate, pink but paler towards the base and often with yellowish veins. *Stamens* 10; filaments lanceolate, narrow-acuminate, 4-10 mm. long, membranous, with long villous hairs at the margin and on the mid-rib near the base; anthers sub-globular, yellow. *Ovary* hirsute; stigmata white, green, or pale pink, 1-3 mm. long. *Fruit*: mericarps oblong or ovoid, 2.5-4 mm. wide, covered with stiff simple hairs and some minute glandular ones, funicular hairs c. 35; awns covered with stiff patent or antrorse simple hairs with some minute glandular ones on the outer surface; rostrum 9-20 mm. long. *Seed* black, sub-globular, 2-8 mm. long, with coarse more or less isolateral alveolae and a basal raphe.

var. SOLANDERI.

Tap-root almost always napiform. *Stems* decumbent, whole plant covered with reflexed or patent hairs. *Sepals* c. 5 mm. long. *Petals* c. 6 mm. long. *Stigmata* 1 mm. long. Mericarps ovoid, c. 2.5 mm. long. Rostrum 9-12 mm. long. Stems sometimes rooting at the nodes.

Range. Very widespread in temperate Australia including Tasmania and into New Zealand. Apparently introduced into California.

Habitat. Variable but usually in drier plant communities.

Typification. All of the synonyms cited are synonyms of the type variety. *G. solanderi* Carolin—Holotype—Habitat in New Zealand, Forster, sub "G. pilosum Forst" (K) see Carolin, 1963 for discussion of Forster's types; in any case this is the only relevant specimen which has been located. The types of *G. pilosum* Sol., *Prim. Fl. N. Zeal.*, msc (BM), are irrelevant as they refer to an unpublished name. *G. pilosum* Sol. ex Willd. Willdenow presumably based this description on J. R. Forster's material named by Solander for J. G. A. Forster's "Prodromus" which reached him in 1799 via Sprengel (Carolin, 1963). In any case the name is not available as it is a later homonym of *G. pilosum* Cav. *G. dissectum* var. *pilosum* is based upon the material at Kew derived from J. R. Forster's herbarium; it would, then, appear to be duplicate material of that used by Willdenow or it might even be identical. Hooker, however, refers only to the nomen nudum of Forster and the variety must therefore be attributed to him alone.

G. dissectum var. *australe* Benth.—Lectotype—*G. pilosum* Sol. ex Willd. When Bentham described this variety he included within it most of the species described before 1863. None of these synonyms was referred to as being more important than the others. As this combination has been used most frequently to cover the species at present under discussion the lectotype is selected so that it becomes a synonym.

G. patulum Sol. is a nomen nudum.

Named after Daniel Solander who first described the species under the name "G. pilosum" in msc. *Prim. Fl. N. Zeal.*

Discussion. Both the nomenclature and the biology of this species are involved. Only one variety is recognized here, but there is considerably more variation than this.

implies. Other characters also vary, but the differences appear to grade into each other and there appears to be no obvious correlation of characters. Notable in this respect are sepal shape and indumentum, the latter varying from stiff reflexed to soft patent, or even puberulent, hairs, and the former from ovate to lanceolate-elliptic.

The important *differentiae* which serve to separate this species from allied ones are the patent or reflexed hairs, napiform roots and the coarse alveolae of the black or very dark brown seeds.

The species has been frequently compared and confused with *G. carolinianum* L. and *G. dissectum* L. Fernald has dealt with these species in North America, see *Rhodora*, 37: 298 (1935), and the Australian species with which they have been confused can be distinguished from these two as follows:

1. Annual. Flowers twinned and frequently grouped into heads. Pedicel and rostrum with some long glandular hairs. Seeds brown with small, shallow, elongate alveolae, oblong with a more or less lateral raphe *G. carolinianum*.
2. Annual. Flowers twinned, not grouped into heads. Pedicels and rostrum with numerous long glandular hairs. Seeds pale brown with large isolateral deep alveolae, more or less globular with a basal raphe *G. dissectum*.
3. Perennial. Flowers twinned, not grouped into heads. Pedicels and rostrum with no long glandular hairs. Seeds black or very dark brown with large usually isolateral distinct alveolae, globular or sub-globular with a more or less basal raphe *G. solanderi*.
4. Perennial. Flowers solitary. Pedicels and rostrum with no long glandular hairs. Seeds brown with small shallow elongate alveolae, oblong with a lateral raphe ..
..... *G. potentilloides*.

The *differentiae* are considered to be of specific significance and the action of earlier workers in including all these species under *G. dissectum* can no longer be justified.

Selected Specimens examined: *Western Australia:* Mt. Mylup, A. Oldfield No. 496 (MEL); Gordon River, Oldfield No. 123 (MEL). *South Australia:* Mambray Creek, lower Flinder's Range, Adel. Bot. Gard., Oct. 1960 (AD 96139066); Kinchina nr. Murray Bridge, M. C. R. Sharrard No. 712, 14.8.1960 (AD 96149261); Mount Lofty Ranges, J. B. Cleland, 12.12.1961 (AD 96104204); Flinders Range Wilpena, D. E. Symon No. 566, 13.9.1960 (ADW). *Victoria:* Narbethong nr. Healesville, R. Carolin No. 1107, 6.1.1960 (SYD); Mt. Buller, R. Carolin No. 1099, 5.1.1960 (SYD); Warrandyte, A. Meebold No. 21703, Nov.1936 (NSW 42619); Mt. Eccles, H. I. Aston, 21.10.1960 (MEL); Spring Creek, H. I. Aston No. 633, 12.10.1960 (MEL); Gattamurrah Gap, J. H. Willis, 25.2.1962 (MEL); St. Kilda, F. von Mueller, Sept. 1852 (MEL). *King's Island:* Chas. Walters, 11.1887 (NSW 42638). *Tasmania:* c. 2 miles n. of Dee Lagoon nr. Lyell Highway, R. Carolin No. 1323, 16.1.1960 (SYD); Mt. Nelson, R. Carolin No. 1767, 6.2.1960 (SYD); Devonport, R. Carolin, No. 1113, 7.1.1960 (SYD); The Gardens, sth. end of Bay of Fires, R. Carolin No. 1903, 12.2.1960 (SYD); Recherche Bay, R. Carolin No. 1416, 22.1.1960 (SYD); Hobarton, J. Backhouse No. 92, 1834 (BM). *New South Wales:* The Creel nr. Jindabyne, R. Carolin, No. 773, 24.1.1959 (SYD); Burruga-Rockley, R. Carolin No. 938, March 1959 (SYD); Cox's Gap, R. Carolin No. 2070 (SYD); 10 miles S.E. of Nowendoc, R. Carolin No. 2064, 19.12.1960 (SYD); Mungyang near Guthega, R. Carolin No. 784, 25.1.1959 (SYD); Bungonia Caves, R. Carolin No. 841, 1.3.1959 (SYD); Oberon, R. Carolin No. 920, 23.3.1959 (SYD); The Oaks, Camden, S. M. McKay, 14.3.1958 (SYD); Ryde, O. D. Evans, 1.9.1924 (SYD); Chandler's Peak, J. L. Boorman, 3.1917 (NSW 42595); Bateman's Bay, J. L. Boorman, 6.1906 (NSW 42678); Currarong near Shoalhaven River, F. A. Rodway, 2.1928 (NSW 42675); Gudgenby, R. H. Cambage No. 3380, 13.1.1912 (NSW 42574); Merrigoen via Mudgee, F. H. Brown, 6.1899 (NSW 42690); 3 miles n. of Wallabadah, R. H. Goode No. 107, 11.11.1954 (BM). *A.C.T.:* Canberra, O'Connor district, R. D. Hoogland No. 3107, 10.1.1953 (CANB. BM). *Queensland:* Cunningham's Gap, R. Carolin No. 573, 15.5.1958 (SYD); Rathdowney, R. Carolin No. 1023, 1.6.1959 (SYD);

Millmerran, C. E. Hubbard No. 5848, 15.3.1931 (BRI 037028.K); Bunyah Mts., C. T. White, 10.19 (BRI 037031); 2 miles S. of Pittsworth, S. L. Everist and L. J. Webb No. 1234, 20.11.1946 (BRI 037032); Q.A.H.S. and College, Lawes, R. Roe, 8.10.1938 (CANB 5360). *New Zealand*: R. Lynd No. 77 (BM); Awamoko, Lower Waitaki Valley, D. Petrie, Oct. 1892 (WELT 30999); Coromandel, D. Petrie, Jan. 1899 (WELT 31004); Mount Eden, J. Kirk No. 644, Nov.19.1868 (WELT 31006); Napier, W. R. B. Oliver, 1913 (WELT 6058); Watchman's Island, Ahuriri Lagoon Napier, A. J. Healy, 13.4.1945 (CHR 58526); Taranga Island, L. B. Moore and L. M. Cranwell, 15.11.33 (CHR 95133); Cockburn-Hornby District, A. J. Healy, No. 56/185, 29.10.1956 (CHR 92182B) pro parte; Weka Creek, N. Canterbury, A. J. Healy, 9.12.1941 (CHR 33655).

var. *GRANDIS*, var. *NOV*.

Radix princeps non napiformis. *Caules adscendentes pilis patentibus mollibus obtecti*. *Pedunculi* 3-4 mm. longi. *Petala* obovata, 12 mm. longa, 5 mm. lata. *Stigmata* 3 mm. longa.

Tap-root thick, woody, branched and swollen but not napiform. *Flowering stems* ascending, up to 60 cm. tall. Whole plant covered with soft patent hairs. *Basal leaves* with petioles up to 20 cm. long; laminae 7-10-lobed, up to 4 cm. long and 6 cm. wide; stipules c. 9 mm. long. *Peduncles* 3-4 cm. long, *pedicels* 3-5 cm. long. *Sepals* 6-9 mm. long. *Petals* obovate, 12 mm. long, 5 mm. wide. *Stigmata* pale pink, c. 3 mm. long. *Mericarps* oblong, c. 4 mm. long. *Stems* apparently never rooting at the nodes.

Range. New England Highlands.

Habitat. Usually in open forest on basaltic soils.

Typification. Holotype—Ebor Gorge, New England, R. Carolin No. 0766, 2.1.1959 (NSW), named after the flowers which are conspicuously larger than those of the type variety.

Discussion. This variety has an apparently restricted range on basaltic soils in northern New South Wales, but may eventually be found to have a more extensive distribution.

Specimens examined: *New South Wales*: Guy Fawkes Creek Gorge, R. Carolin No. 424, 17.11.1957 (SYD); Glen Innes, H. M. R. Rupp, 1.1914 (NSW 42580); Mt. Lindsay, H. M. R. Rupp, 1.1914 (NSW 42591); Clarence River, H. Beckler (MEL).

16. *GERANIUM DRUMMONDII*, sp. nov.

Herba perennis radice principi napiformi et floribus geminis. *Caules petioli pedunculi et pedicelli capillis longis patulis albis plerumque simplicibus vestiti*. *Folia* profunde 7-9-lobata. *Sepala* hirsuta. *Petala* ad basin ciliis longis plurimis. *Semina* fulva (vel nigra?) subglobularia. *Raphe basilari alveolis parvis transverse elongatis*.

Perennial herbs with a thickened napiform tap-root and short thick caulorrhiza covered with dead stipules and leaf-bases. *Flowering stems* decumbent or ascending, usually only sparsely branched, up to 50 cm. long, covered with long stiff patent white simple hairs with a few glandular ones. *Basal leaves* similar to cauline ones but larger and somewhat more deeply dissected. *Cauline leaves* opposite; petioles up to 5 cm. long, hirsute with long more or less patent hairs; laminae orbicular to reniform in outline, up to 2 cm. long and 3.5 cm. wide, covered with more or less appressed white hairs on either surface, deeply dissected into 5-7 segments which are further divided into three mucronate secondary lobes towards the top; stipules membranous, pale brown, linear to lanceolate, c. 3 mm. long, 1 mm. wide, pubescent, ciliate, acute or even acuminate. *Flowers* twinned; peduncles hirsute with dense spreading white simple hairs sometimes more or less entangled, 2-4 cm. long, bracteoles similar to stipules but smaller; pedicels similar to peduncles, up to 2 cm. long, geniculate at the bracteoles and swollen above in the fruiting stages. *Sepals* ovate, 5 mm. long, 2.5-3.5 mm. wide, densely covered with long white more or less spreading simple hairs; membranous and minutely ciliate at the margin with a mucro c. 0.5 mm. long. *Petals* pink (?), obovate, somewhat longer than the sepals, with long marginal hairs towards the base. *Stamens* 10; filaments lanceolate.

c. 4 mm. long, yellow-brown, distinctly ciliate; anthers not seen. *Ovary* hirsute; stigmata red (?). *Fruit*: mericarps smooth, hirsute with long stiff white simple hairs and some minute glandular ones, funicular hairs more or less erect, often almost half as long as the mericarp itself, 20–30; awns densely covered with spreading stiff simple hairs; rostrum 10–13 mm. long. *Seeds* more or less globular, 1.5–2.0 mm. long, with a basal raphe, dark brown (or black) covered with small but fairly prominent alveolae more or less elongated at right angles to the vertical axis.

Range. South-western Australia.

Habitat. Unknown.

Typification. Holotype—Drummond, Swan River No. 4 (K). There are two sheets bearing this number at Kew. Both bear specimens of this species. The sheet marked "4 bis" is the holotype. The type number collection of *G. australe* Nees in Lehm., i.e.,

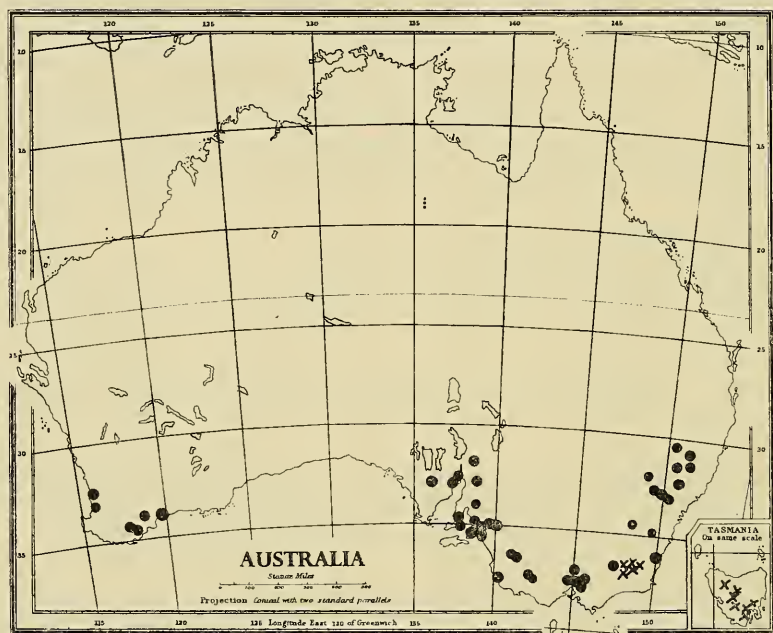


Fig. 9. Distribution of *G. retrorsum* (●), and *G. sessiliflorum* ssp. *brevicaule* (X).

Preiss No. 1907, contains elements of this species; the sheet at Leningrad bears specimens. Nees' description, however, disagrees in a number of respects, notably with respect to the indumentum. Named after the collector of the holotype.

Discussion. The author has not seen this species in the field but the herbarium material is quite distinctive. The long, dense simple hairs on the stems etc., the long basal cilia on the petals, the characteristic alveolae of the seed-coat and the swollen napiform root distinguish it from all the other species. The indumentum, twinned flowers and root form indicate an affinity with *G. solanderi*.

Specimens examined: Western Australia: Yallingup and Cape Naturaliste, A. A. Dorrien-Smith, 1910 (K); Drummond, Swan River No. 501 (K two sheets. MEL. BM).

GROUP V. Perennials with thick but not napiform roots, and with much branched caulorrhiza, covered with very persistent dead petioles. Pedicels more or less erect, not swelling above or geniculate in the fruiting stages. Flowers solitary. Flowering stems short. Seeds black, smooth or with minute alveolae.

17. *GERANIUM SESSILIFLORUM*. Cav., *Diss.*, 4: 198 (1787); Willd., *Sp. Pl.*, 3: 696 (1800); DC., *Prodr.*, 1: 639 (1824); Hook. f., *Fl. Ant.*, 252 (1847); Benth., *Fl. Austr.*,

1: 297 (1863); Hook. f., *Handbk. N. Zeal. Fl.*, 36 (1864); Moore et Betche, *Handbk. Fl. N.S.W.*, 55 (1893); Sprg. in *Anal. Mus. Buenos Aires*, 7: 254 (1902); Rodway, *Fl. Tasm.*, 19 (1903); Cheeseman, *Man. N. Zeal. Fl.*, 89 (1906); Knuth, *Pflrch.-Geran.*, 83 (1912); Simpson et Thompson, *Trans. Roy. Soc. N. Zeal.*, 73: 157 (1943); Ewart, *Fl. Vict.*, 682 (1930); Curtis, *Stud. Fl. Tasm.*, 1: 91 (1956); Allan, *Fl. N. Zeal.*, 1: 234 (1961).

Compact perennial with thick usually much-branched tap-roots and much-branched woody caulorrhiza up to 7 mm. thick and covered with the very persistent stipules and petioles. *Basal leaves* crowded on the upper parts of the caulorrhiza: petioles 2–10 cm.



Southern Pacific Oblique Azimuthal Equidistant centred on c. long. 180° lat. 51°.

Fig. 10. World distribution of *G. sessiliflorum* (incl. spp.).

long, covered with long patent villous hairs and short appressed ones; laminae semi-orbicular to reniform in outline, 5–7 palmately lobed or dissected, 10–20 mm. long, 15–30 mm. wide, covered thickly or thinly with coarse appressed hairs on both sides; lobes oblong-ovate in outline with three secondary lobes above each, each secondary lobe obtuse with a callous tip or the lateral ones tending to be acute; stipules pale to dark brown, oblong to lanceolate-acuminate, c. 6 mm. long and up to 2 mm. wide, covered with short appressed hairs, ciliate at the margin, united to the petiole with only the tips free. *Flowers* solitary, borne on the usually very short annual branches; bracteoles membranous, brown, lanceolate to linear-lanceolate, c. 6 mm. long and 1 mm. wide, covered with short appressed hairs, ciliate at the margin and inserted on the lower third of the pedicel-peduncle; pedicel-peduncle 0.5–3.0 cm. long, more or less erect, densely covered with retrorse-appressed hairs, often with some long divergent ones, not swollen above in the fruiting stages. *Sepals* lanceolate to narrow-elliptic or narrow-oblong, 4–8 mm. long and up to 2.5 mm. wide, acuminate at the tip, covered with long spreading hairs and shorter antrorse-appressed ones, thinner but scarcely membranous towards the margin, ciliate, very slightly convex or flat in the fruiting stages. *Petals* oblong to narrow-elliptic or obovate, 4–8 mm. long, 1–3 mm. wide, deep pink to white with translucent veins, paler towards the base, with minute hairs scattered over the

surface at the margin or rarely glabrous. *Stamens* 10; filaments broad-lanceolate, acuminate, divergent at the apex, c. 2.5 mm. long, ciliate; anthers yellow, more or less orbicular, c. 1 mm. long, with 2-3 bristles at the apex. *Ovary* hirsute; stigmata, deep pink or white, c. 1 mm. long. *Fruit*: mericarps brown, oblong to ellipsoid, 3 mm. long, 1.5 mm. wide, covered with stiff spreading hairs; funicular hairs mostly erect, c. 25; awns covered with stiff short simple hairs and some minute glandular ones on the outer surface; rostrum 8-10 mm. long. *Seeds* black to very dark brown, ovoid to ellipsoid, c. 2.5 mm. long and 1 mm. wide, obscurely reticulate; raphe lateral.

ssp. *SESSILIFLORUM*.

Indumentum various; hairs of the calyx short and appressed with long $\pm$ divergent villous ones towards the margin; mucro of the sepal c. 0.5 mm. long or obsolete. Petals oblong, scarcely clawed at all, 1.5-2 times as long as the sepals, red to white.

Range. South American Highlands, coming down to sea-level in higher latitudes.

Habitat. Grasslands and sand-dunes.

Discussion. This subspecies does not come within the geographic limits of this treatment. It is included to point out the distinctions between it and the Australasian material.

ssp. *NOVAEZELANDIAE*, ssp. nov.

Pili calycis plerumque appressi patentiores longioresque versus marginem inserti. Petala obovata longiore sepalam.

Indumentum various; hairs of the calyx appressed, with the long divergent ones tending to be inserted towards the margin; mucro of the sepal c. 1 mm. long, frequently divergent or even reflexed in the fruiting stage. Petals obovate, clawed, c. 1.5 times as long as the sepals, usually white.

var. *NOVAEZELANDIAE*. Leaves glabrescent to $\pm$ hirsute, green.

Taxonomic Synonyms. *G. sessiliflorum* var. *maculatum* Simpson et Thomson, *loc. cit.*

Indumentum $\pm$ thinly scattered. Leaves dark green, not glaucous.

Range. New Zealand.

Habitat. Grasslands to fairly high altitudes.

Typification. *G. sessiliflorum* ssp. *novaezealandiae*. Holotype—Saddle between Shin & Hodder Rivers, Inland Kaikoura Mts., Marlborough, B. G. Hamlin No. 915, 4 Dec. 1960 (WELT 11508); *G. sessiliflorum* var. *maculatum* Simpson et Thomson—holotype—shores of Lake Lyndon, G. Simpson and J. S. Thomson (CHR 75697).

Discussion. The diagnostic characters given in the main description separate this subspecies from the other two. It approaches closest to ssp. *sessiliflorum* in the sand-dune variety (below). It seems possible that it hybridizes with *G. potentilloides*.

Selected Specimens examined: New Zealand: Makara Hills, Wellington, A. P. Druce, 21.11.1947 (CHR 82267); Red Rocks Point, A. J. Healy, 8.12.1940 (CHR 33222); Desert Road, L.B.M., April 1955 (CHR 91942); Hora Hora, Middle Waikato, D. Petrie 16.11.1912 (WELT 30924); Tarawera, Hawke's Bay, D. Petrie, 2.2.1909 (WELT 30923); Upper Rangitikei Ford, D. Petrie, Jan. 1915 (WELT 30939); Mt. Arthur, Nelson, J. A. Hay, 26.12.50 (CHR 89927); Summit Road, Banks Peninsula, T. W. Rawson, 28.12.1954 (CHR 94041); Eweburn Creek, C. Otago, sine coll. (CHR 95149); S. bank of L. Taylor, Upper Huranui, A. Lush, 8.11.1948 (WELT 30946); Porter's Pass, M.S., 6 Feb. (WELT 30944); Mingria valley, W. R. B. Oliver, 13.1.1928 (WELT 30907).

var. *ARENARIUM* Simpson et Thomson in *Trans. Proc. Roy. Soc. N. Zeal.*, 73: 158 (1943).

Leaves densely covered with greyish appressed hairs.

Range. New Zealand, south part of the South Island.

Habitat. Coastal sand-dunes.

Typification. Holotype—Paterson Inlet, Stewart Island, G. Simpson (CHR) but not located.

Discussion. A fairly distinct form occupying a rather specialized habitat. In some specimens it approaches ssp. *sessiliflorum* which also may occur on sand-dunes.

Selected Specimens examined: New Zealand: Fisherman's Bay, H. H. Allan, Jan. 1946 (CHR 76192); nr. Dunedin sine loc. et coll. (CHR 95148); Ramaru, H. H. Allan, 1.1929 (CHR 972); Dog Island, T. Kirk, Jan. 18.1884 (WELT 30934); Sealer's Bay, Codfish Island, R. K. Dell, 4.1.1948 (WELT 30945); Sandhills near Dunedin, G. M. Thomson, sine date (WELT 30930).

ssp. *BREVICAULE* (Hook. f.), comb. et stat. nov.

Nomenclatural Synonym. *G. brevicaule* Hook. in *Hook. Journ. Bot.*, 1: 252 (1834); Hook. f., *Fl. N. Zeal.*, 1: 40 (1852). *BASIONYM.*

Taxonomic Synonym. *G. sessiliflorum* var. *glabrum* Knuth in *Bot. Jahrb.*, 37: 565 (1906) et *Pflrch.-Geran.*, 85 (1912).

Indumentum various. Hairs of the calyx: some short and appressed, with long stiff $\pm$ divergent ones scattered amongst them; mucro of the sepal 1 mm. or longer. *Petals* oblong to oblanceolate or narrow-elliptic, scarcely clawed at all, pink, shorter than to slightly exceeding the sepals.

Range. Tasmania and the S.E. highlands of continental Australia.

Habitat. Grasslands and woodlands, usually at high elevations.

Typification. *G. brevicaule* Hook.—Lectotype—Gunn No. 256; two collections are cited with the original description: "Van Diemen's Land, Gunn 256 and 324". There do not appear to be any specimens of the latter at Kew. Allan (*loc. cit.*) appeared to think that the type was "Chalky Bay, Lyall" at Kew: this is not so. *G. sessiliflorum* var. *glabrum* Knuth—Lectotype—Tasmania, Archer ex herb. Hooker (B, isolectotypes K.). Knuth included here both Tasmanian and New Zealand specimens. These syntypes were presumably destroyed during the war and I have been unable to locate any of the New Zealand material cited by Knuth. I have, therefore, chosen, as the lectotype, the specimen of which duplicates are available. It agrees fairly well with Knuth's very brief description.

Selected Specimens examined: Tasmania: 14 miles Wilmot-Waldheim, R. Carolin No. 1198, 10.1.1960 (SYD); 71 miles Hobart—Dee Lagoon, R. Carolin No. 1368, 16.1.1960 (SYD); 2 miles north of Dee Lagoon, Lyell Highway, R. Carolin No. 1326, 16.1.1960 (SYD). *New South Wales:* Daner's Gap, Kosciusko, M. Woodward, 21.1.1958 (SYD); Kiandra Distr., E.B.(etche), 2.1897 (NSW 42540); Bett's Creek, Kosciusko, L. A. S. Johnson & E. F. Constable, 25.1.1951 (NSW 15782).

18. GERANIUM ANTRORSUM, sp. nov.

Herbae confertae vix expandentes. Folia lobis tenuibus. Flores solitaires bracteolis. Partem in tertiam infimam pedicello-pedunculi insertis. Pediceli pilis albis antrorso-appressis. Petala obovata. Sepala lanceolato-acuminata circum fructum concava. Semina nigra obscure reticulata.

Perennial herb with thick fleshy branched tap-roots and numerous much-branched caulorrhiza (usually less than 3 mm. long), thick and covered with very persistent stipules and petioles. *Flowering stems* very short and bearing reduced leaves or reduced to a pedicel-peduncle. *Basal leaves* crowded towards the top of the caulorrhiza; petioles 3-16 cm. long, densely covered with appressed hairs and some more or less spreading villous ones; laminae semi-orbicular to cuneate in outline, 5-7 palmately dissected or lobed, 1-4 cm. long, 1.5-3.0 cm. wide, covered with coarse appressed hairs on both surfaces; lobes obovate, further divided into three secondary lobes above, the central one obtuse, the two lateral ones tending to be acute, scarcely mucronate; stipules brownish, membranous, oblong to elliptic or lanceolate, 4-6 mm. long, up to 2 mm. wide, obtuse or slightly acuminate, ciliate at the margin and with a distinct ciliated mid-rib. *Flowers* solitary on erect peduncle-pedicels; pedicel-peduncle 1-4 cm. long, densely

covered with antrorse sub-appressed hairs, not swollen above in the fruiting stages; bracteoles lanceolate to linear-lanceolate, c. 6 mm. long, ciliate and pubescent, inserted about one-third distance from the base. *Sepals* lanceolate to narrow-elliptic, long acuminate, 5–11 mm. long, 2–3 mm. wide, covered with closely antrorse-appressed hairs and with spreading hairs on the veins and on the membranous margins, concave in the fruiting stages and with spreading tips. *Petals* obovate, 6–12 mm. long, deep-pink with translucent veins, and paler towards the base, entire. *Stamens* 10; filaments lanceolate-acuminate, 2–3.5 mm. long, ciliate; anthers globular, c. 1 mm. diam., yellow with purple dehiscence lines. *Ovary* hirsute-villous; stigmata pink, c. 2 mm. long. *Fruit*: mericarps dark brown, covered with spreading hairs, funicular hairs erect, c. 25; awns covered with short coarse simple hairs and some minute glandular ones on the outer surfaces; rostrum c. 11 mm. long. *Seeds* black, ovoid, c. 2.5 mm. long and 1.5 mm. wide, obscurely reticulate; raphe lateral.

Range. Highlands of south-eastern Australia.

Habitat. Alpine and sub-alpine grasslands.

Typification. Holotype—Kosciusko Hotel dam, R. Carolin No. 778b, 24.1.1959 (NSW 66132), named after the antrorse hairs on the pedicel-peduncle.

Selected Specimens examined: Victoria: Mt. Buller, J. H. Willis, 9.3.1953 (MEL); Quambat Plain, W. Hunter, Dec. 1938 (MEL); Mt. Tainter, Bogong High Plains, A. J. Tadgell, 28.2.1926 (MEL); Cobungra, H. B. Williamson, Dec. 1928 (MEL); N.W. of Cobungra, T. & J. Whaite No. 1959, 2.1.1960 (NSW 50174). *New South Wales*: east of Nimitybelle, R. H. Cabbage No. 1850, 9.2.1908 (SYD); White's River Hut nr. Guthega, R. Carolin No. B103, 12.2.1957 (SYD); Yarrangobilly Caves, R. Carolin No. 761, 21.1.1959 (SYD); Snowy Mountains, between Charlotte pass and Snowy River, Hj. Eichler No. 13652, 5.2.1957 (SYD AD 95748026). *A.C.T.*: Upper Cotter Homestead, N. Burbidge No. 6371, 24.2.1959 (CANB 58449); Mt. Ginini, M. Gray No. 3570, 10.12.1958.

Discussion. This species has, to date, been included in *G. sessiliflorum* Cav. The main characters separating it from ssp. *brevicaule* are the antrorse hairs on the pedicel-peduncle, sepals concave in the fruit with divergent awns, petals obovate and the slightly different seed-coat pattern. It has a restricted distribution in the alpine areas of the south-east of the continent only and it is apparently not found in Tasmania. Its nearest affinities are, without doubt, with *G. sessiliflorum*.

There is a specimen from Dry Plain, which shows affinities with this species, but differs in the dense silvery indumentum and the narrow-linear segments to the leaves. A search has been made in the locality for further specimens but none have been found to date. As the specimen lacks some of the organs which provide the *differentiae* used in this treatment it has not been technically described here. It does not appear to be an introduced species and it has not been possible to equate it with any known species at all.

Key to the Species in Australia.

1. Surface of the mericarp glabrous and usually wrinkled *G. molle*.
- 1.* Surface of the mericarp hirsute to pilose, smooth.
2. Awns of the mericarps with conspicuous glandular hairs; seeds pale brown.
3. Leaves with broad lobes; petals clawed, glabrous *G. rotundifolium*.
- 3.* Leaves with linear lobes; petals not clawed, ciliate towards the base *G. dissectum*.
- 2.* Awns of the mericarps with mostly simple hairs and sometimes some minute glandular ones; seeds black or dark brown.
4. Flowers mostly twinned.
5. Hairs of the pedicel retrorse-appressed in flowering stage.
6. Tap-root branched, not napiform; leaf-lobes broad; seeds dark-brown with more or less elongated alveolae *G. homeanum*.
- 6.* Tap-root napiform; leaf-lobes usually linear; seeds black or very dark-brown with isolateral alveolae *G. retrorsum*.
- 5.* Hairs of the pedicel retrorse-reflexed or patent, never appressed.
7. Seeds with large alveolae; hairs stiff *G. solanderi*.

- 7.* Seeds with very small alveolae; hairs long and often more or less entangled *G. drummondii*.
- 4.* Flowers solitary.
8. Flowering stems usually shorter than basal leaves or reduced to a single pedicel-peduncle; seeds black, smooth or with minute alveolae.
9. Hairs of the pedicel retrorse-appressed; petals narrow-oblong *G. sessiliflorum* ssp. *brevicaule*.
- 9.* Hairs of the pedicel antrorse-appressed; petals oblong to obovate *G. antrorsum*.
- 8.* Flowering stems usually longer than the basal leaves; seeds with distinct alveolae.
10. Seeds black with large alveolae.
11. Bracteoles usually at the base of the pedicel-peduncle; petals pink *G. potentilloides* var. *abditum*.
- 11.* Bracteoles more or less inserted at the mid-point of the pedicel-peduncle; petals white *G. graniticola*.
- 10.* Seeds brown with small alveolae.
14. Tap-root napiform; sepals obtuse *G. obtusisepalum*.
- 14.* Tap-root not napiform; sepals with a distinct mucro.
15. Petals c. 14 mm. long; pedicel-peduncle c. 8 cm. long *G. neglectum*.
- 15.* Petals up to 10 mm. long; pedicel-peduncle up to 5 cm. long *G. potentilloides*.

GENERAL DISCUSSION.

The relationships of the Australian native *Geranium* species to others and the natural distribution of these natives which occur elsewhere show the well-known sub-antarctic relationship. Thus *Geranium potentilloides*, occurring in South-eastern Australia, New Zealand, New Guinea and into the mountains of Celebes, Timor and Java, shows a close affinity to the South American species grouped around *G. magellanicum* (Fig. 3). This is a similar situation to that found in such genera as *Nertera* and *Oreabolus* (van Steenis, 1962); a bifurcation of distributional tracts, one into Australia from the south and a second, northwards from the sub-antarctic zone, into the Malaysian region and becoming the "Papuan track" (van Steenis, 1935). It does not, however, conform absolutely to this latter since there are outliers of this species distributed within the "Sumatran track". It is interesting to note that those specimens occurring in this latter track are distinguishable fairly readily from the type, as var. *ardjunense* and, furthermore, that those closest to the Papuan track, i.e., in Southern Celebes, are closest morphologically to the type. This species extends to Sumatra and even shows some affinities with *G. nepalense* Sweet, as suggested by Lam (1945). Croizat (1952) maintains that this var. is a link "within a long continuous chain of affinities stretching South to North between Chatham Islands and the Himalayas". It seems we can extend this chain of affinities to South America and even North America. He suggests the group's dispersal "takes its start somewhere between New Zealand and Tasmania [sic!] and invades Timor from Australia, next following to Java and Sumatra". *G. potentilloides*, however, is essentially a microtherm species and there must be some doubt as to whether such conditions ever existed in northern Australia. The very close affinity of the alpine flora of New Guinea to that of New Zealand makes it seem probable that some fairly close floristic connection between these two land masses has existed in the past, possibly via an archipelago of islands along the Chatham Island ridge. Such, however, must remain speculation for so little is known of the past climatic history of northern Australia and the tectonic history of the sea-bed to the east. In Papua the alpine *G. monticola* has differentiated.

Geranium retrorsum and *G. solanderi* also show an affinity with the *G. magellanicum* group, but rather less so than *G. potentilloides*, although it must be admitted that too little is known about the South American species. *G. retrorsum* and *G. solanderi* appear to have developed as an adaptation to rather drier conditions in Australasia. They do not appear to have followed the Papuan track into Malaysia, possibly because the conditions to which they adapted are much less common, even in Papua itself.

G. homeanum is another derivative of this sub-antarctic group which shows adaptation to the damp conditions of montane forests and marginal rain-forest conditions

(micro-mesotherm). It shows a very well-developed southern limb of the bifurcation in south-eastern Australia, but the northern limb is quite disjunct, at least at present. It has been collected on one of the East Javanese mountains, in the centre of Sumatran track, but nowhere, so far in the Papuan track (Fig. 7). It is possible that this is a recent introduction, although it might be accepted as an outlier in Indonesia of an invader, from the sub-antarctic, presumably along the Papuan track. A disjunction of a similar order has been reported, recently, in *Viola hederacea* (Moore, 1962), a species with similar ecological requirements to those of *G. homeanum*.

G. sessiliflorum shows a classical sub-antarctic distribution (Fig. 10). It, and its relatives, are unknown in Papua. The section has reached its highest development in the Andes, but in Tierra del Fuego and the southernmost parts of the mainland it extends down to sea-level and apparently forms part of the sand-dune flora. It is interesting to note that the New Zealand subspecies also extends to sea-level in the South Island and there, also, inhabits sand-dunes. Whilst still quite easily distinguishable from each other, it is in these two littoral forms from the two sides of the Pacific that ssp. *sessiliflorum* and ssp. *novaezealandiae* approach closest to each other in general morphology. This may, of course, be simply a result of selection by the two similar environments or it may be an indication of the manner in which the ssp. has invaded New Zealand from South America. In Australia it is essentially a highland species together with the apparently derivative *G. antrorsum*.

Within Australia it is rather difficult to discuss distributions since collections of this genus from Western Australia are so few. However, it seems that the various climatic fluctuations and the formation of the Great Australian Bight cannot wholly explain the distribution of Group IV. *G. retrorsum* is found in both the S.E. and in the S.W., implying that the arid area north of the Bight is not an efficient barrier or that there has been little evolution on either side since the barrier was formed. *G. drummondii* may have developed as the western equivalent of *G. solanderi*, but the variation within the latter is so great that it is impossible to argue effectively without more collections being made.

By far the most important factor in speciation of *Geranium* in Australia must have been the uplift of the south-eastern highlands. Not only did this supply the alpine conditions necessary for the establishment of Sect. *Andina*, but also the rainfall necessary for the establishment of subtropical to montane rain-forest (*G. homeanum*) and montane woodlands (*G. potentilloides*). Furthermore, along the dividing range so created, a considerable number of environments of fairly local occurrence were formed. Some of these were exploited by the *G. potentilloides*-group as mostly they were of a damp nature. *G. neglectum* is the best example, a form adapted to bogs in montane woodlands; others are *G. obtusisepalum* in upland grasslands and sub-alpine woodlands, *G. graniticola* in montane woodlands on granite. Again, this divide produced something of a rain-shadow to the east enabling the dry-land species, *G. retrorsum* and *G. solanderi*, to become such a prominent component of the "Western Slopes" communities. Since peneplanation of eastern Australia seems to have been so widespread during the Miocene, much of the speciation within Group III must have taken place at least since then or, more probably, since the great uplift in Pliocene times. This is not to say that it may not be more recent still. Indeed, the advent of the microtherm species must also follow this pattern, at least as far as the mainland is concerned. The tectonic history of Tasmania is not so well known, but it is possible that the microtherm species have had a somewhat longer history there.

Van Steenis (1962) suggests that a land-bridge existed between South America and Australasia via Antarctica which more or less disappeared towards the upper Cretaceous. His curt dismissal of the continental drift theory is unfortunate, but the evidence for this land connection is very considerable. The fact that it is the microtherm species of *Geranium*, and not the mesotherm ones, which show this connection most clearly lends weight to the contention that the Antarctic continent itself supported a cool temperate flora during the Cretaceous and Tertiary and not a warm temperate flora.

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References.

- BENTHAM, G., 1863.—*Flora Australiensis*. London.
 CAROLIN, R. C., 1963.—J. R. & J. G. A. Forster and their Collections in the South Pacific. *PROC. LINN. SOC. N.S.W.*, 87: 108.
 CROIZAT, L., 1952.—*Manual of Phytogeography*. The Hague.
 EICHLER, A. W., 1878.—*Bluthen-Diagramme*. Leipzig.
 KNUTH, R., 1912.—*Pflanzenreich-Geraniaceae*. Berlin.
 LAM, H. J., 1945.—Contributions to our knowledge of the Flora of Celebes and of some other Malaysian Islands. *Blumea*, 5: 554.
 MOORE, D. M., 1962.—*Viola hederacea* Labill. in Malaya. *Blumea*, 11: 535.
 MOORE, H. E., 1961.—A remarkable new *Geranium* from Ecuador. *Britt.*, 13: 141.
 VAN STEENIS, C. G. G. J., 1934, 1935, 1936.—On the origin of the Malaysian mountain flora. *Bull. Jard. Bot. Buitz.*, ser. III, 13: 135, 289; 14: 56.
 ———, 1962.—The Land-Bridge Theory in Botany. *Blumea*, 11: 235.

EXPLANATION OF PLATES VI-VII.

Plate vi. Seeds of *Geranium* species.

1. *G. retrorsum*. R. Carolin no. 3450 (SYD).
2. *G. solanderi*. R. Carolin no. 920 (SYD).
3. *G. solanderi*. C. E. Hubbard no. 5848 (K).
4. *G. drummondii*. HOLOTYPE (K).
5. *G. homeanum*. R. Carolin no. 842 (SYD).
6. *G. potentilloides*. R. Carolin B68 (SYD).
7. *G. potentilloides*. R. Carolin no. 807 (SYD).
8. *G. potentilloides*. R. Carolin no. 1768 (SYD).
9. *G. potentilloides* var. *additum*. HOLOTYPE (NSW).
10. *G. graniticola*. HOLOTYPE (NSW).
11. *G. obtusisepalum*. HOLOTYPE (NSW).
12. *G. neglectum*. HOLOTYPE (NSW).
13. *G. sessiliflorum* ssp. *brevicaule*. R. Carolin no. 1368 (SYD).
14. *G. antrorsum*. HOLOTYPE.
15. *G. dissectum*. R. Carolin no. 1231 (SYD).

Plate vii. Fruiting pedicels of *Geranium* species.

1. *G. solanderi*. R. Carolin no. 786 (SYD).
2. *G. solanderi*. R. Carolin no. 841 (SYD).
3. *G. retrorsum*. R. Carolin no. 3450 (SYD).
4. *G. homeanum*. R. Carolin no. 842 (SYD).
5. *G. potentilloides*. R. Carolin no. 605 (SYD).
6. *G. potentilloides*. R. Carolin no. 1600 (SYD).
7. *G. obtusisepalum*. HOLOTYPE (NSW).
8. *G. neglectum*. HOLOTYPE (NSW).
9. *G. graniticola*. HOLOTYPE (NSW).
10. *G. antrorsum*. HOLOTYPE (NSW).
11. *G. sessiliflorum* ssp. *brevicaule*. R. Carolin no. 1368 (SYD).